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Welded Boilers

THE art of joining metals by welding is having a profound effect upon constructional engineering and is bound to modify the methods seriously and add to the possible achievements of the mechanical engineer.

It took years for the world, even the professional world, to recognize the possibilities that had come with the easy production of very high temperatures on limited areas of application.

To the general mind fusion welding smacked of the soft solder and brazing possible with the ordinary temperatures formerly available. A weld was regarded as more in the nature of a glued joint than as, what it is when properly made, an intimate union of the parts into an integral whole.

It took years of research and experiments and the expenditure of vast sums of money to work out the crudities, try out materials, develop a trained personnel and organize the procedure to produce a juncture that should be as strong as the parts united, ductile and free from flaws and inclusions, without setting up internal stresses or inducing grain growth and change of molecular structure in the contiguous metal.

The work produced by some of the companies specializing in this line is wonderful in its attainment of the desirable qualities of a joint, and vessels made by them are used in chemical and refining processes with reliability under extremes of pressure and temperature that would have been thought extremely risky a few years ago.

With this accomplishment to their credit the promoters of welding are somewhat impatient with the Boiler Code Committee of the A.S.M.E. because it refuses to permit the use of welding for boiler parts under stress.

The Committee is not unmindful of the progress and possibilities of the art and would impose no restrictions to its application unessential to the public safety.

But while it recognizes that much reliable and really creditable work is being done, anyone can buy a torch and not everyone knows how to use one.

What is needed is a specification for material and procedure which, being followed, will produce a reliable joint.

The details of such specifications being known, the Committee can provide that joints made in accordance therewith shall be allowed a certain unit stress.

An elaborate series of tests of pressure vessels is to be conducted by a Joint Research Committee organized by the American Bureau of Welding and the American Society of Mechanical Engineers. It is hoped that this study will determine the pressure safely allowable on tanks that have been welded according to certain specifications.

If it does, the Boiler Code Committee can write into the Code the pressure and procedure.

Then it will be the affair of the inspector to see that the prescribed materials are used and the specified procedure followed.

F. R. Low

Sauce for the Goose is Sauce for the Gander

MANY of the auxiliaries in the East River Station of the New York Edison Company are driven by steam turbines. Some months ago George A. Orrok, consulting engineer for the company, said that in the investigation leading to this choice, it was found that the thermal economy was sensibly the same for steam and electric drive, with a balance in favor of steam in respect of reliability and first cost.

The steam-driven auxiliaries at East River exhaust into a feed-water heating system, so that the demand for exhaust steam is roughly proportional to the load on the turbines furnishing it. This important fact must not be overlooked.

An industrial plant can make steam as cheaply as can a central station. If there is use for all the exhaust steam, the industrial plant can generate power from this steam as effectively as it is done at East River.

The central station generates power cheaper than the customer can buy it, obviously. If steam power can successfully compete with electric power within the central station, where electric power is cheap, why should an industrial plant ever buy power if it is so situated that *all* the steam exhausted by power generating units could be used for necessary heating?

Modification of the Sherman Law

SOME agitation is current for modification of the Sherman Anti-Trust Law to permit combinations, agreements or the exchange of information among manufacturers under conditions conducive to public welfare.

This law, it will be recalled, was enacted in 1890 and contained drastic provisions aimed at correcting abuses that had grown up in the preceding decade. Since then Congress has seen fit, from time to time, to legislate exceptions. The Clayton Act of 1914, excepting labor and agriculture, the Federal Reserve Act, excluding National banks, the Webb-Pomerene Act, permitting combinations in foreign trade, and the Transportation Act of 1920, providing for consolidations of certain railroad properties, are examples of the willingness of Congress to meet changed conditions.

With respect to business in general, however, the law remains unchanged.

Interpretations by the courts have not been consistent, in consequence of which the legal department of our government has often hesitated to make rulings. This uncertainty has caused business in many cases to lean backward in fear of committing acts that might be construed as violations.

Since the Sherman Law was put on the books, nearly forty years ago, economic forces have brought about many changes. Big business is no longer viewed with suspicion because of its size. On the contrary, in many lines it is credited with having kept down prices to the consumer and promoted research and developments that have greatly advanced our standards of living. On the other hand, the Sherman Law has often worked to the detriment of small manufacturers by preventing agreements and co-operation aimed at the elimination of wasteful practices.

The present proposals for modification of this law would permit agreements and combinations that are clearly in public interest through the lowering of prices, improved service, the raising of quality, or reduction of waste. The Federal Trade Commission, with its membership enlarged, would exercise control over such matters.

Repeal of the Sherman Law would not be tolerated by the American people who regard it as a bulwark against exploitation through unscrupulous business methods. There is growing recognition, however, that changed conditions often necessitate changes in laws. To this end such modifications as might clarify the situation and benefit the public would probably receive general approval.

Why Not Use Oil Specifications?

THAT some Diesel plants have trouble with fuel oil is the fault of the management. Oil, unlike coal, does not come from a definite seam or even field. The fact that oil is from the mid-Continental field is not an indication of its chemical makeup, or of its physical conditions.

Too many are buying oil blindly on a Baumé gravity basis. Now Baumé gravity is no criterion of quality. It simply is a measure of the specific gravity and, contrary to a well-nigh universal belief, gravity does not gage even the flowing quality of an oil. In fact, the Baumé reading is of no value to the oil buyer. What the plant operator and manager need to know are the amounts of water, sulphur, coke, dirt, ash and foreign matter, such as salt, contained in the oil. These are the things that make an oil unsuitable.

In the absence of a standard the purchaser should insist on the oil marketer supplying oil within the requirements set down by the engine builder. To list each car of oil is not expensive and is well worth while. This matter of fuel-oil specifications is one worthy of the attention of the engineering societies.

Imagine the Savings!

IMAGINE what a difference it would make in the economy and efficiency of the heating processes of some industrial plants if the control of these processes were placed under the supervision of the power engineer. Of course most plants now do this, but there are some large plants that still do not. For instance, one of the largest candy plants in the country leaves the control of temperatures in its cooking processes entirely up to the production men. And how those cooks do waste steam!

Exact control is the business of a power engineer. If the production men of those plants that do not yet realize this will tell the power engineer how much heat they need and when they need it, he will see that they get it and make savings for them in the bargain. All that he needs is a specification for the service required and authority to carry it out. The necessary equipment is probably installed already.

And, if the management of these backward plants only realized the share of the cost of their finished products that these wasted B.t.u. represent, they would soon see to it that the control of heat-using processes was given to the power engineer. Some day they will realize why it is that more progressive plants in the same industry turn out goods at lower prices. And, when they do, imagine the savings that will be made!

Sound Welds—And Sound Thinking

THE American Welding Society, which holds its annual Spring meeting this week, is rendering an outstanding service to American industry. It rests, as most successful institutions must, on service to its membership. But its "selfishness" is so enlightened and broadgage as to be, in effect, a very practical form of altruism. Those users and manufacturers who have been most active in the affairs of the Society are men of notable vision, who refuse to undermine confidence for temporary gain.

As a young and virile industry, finding new applications almost daily, welding has received much publicity. This may tend to hide the fact that the real leaders in this field have no desire to promote an unnatural expansion. What they want is a growth based on sound applications and methods. The legitimate field of this art is so vast that they dare not endanger it by promoting the idea that welding is a foolproof process.

This attitude comes to a focus in the American Welding Society. From the start it has backed every research project designed to reveal and cure the hidden faults of welds. Movements to promote rigid procedure control and inspection of welds have had its constant and wholehearted backing. The Society is giving intense study to problems encountered in new or proposed fields of application and refuses to be stampeded. No sane proponent of welding courts the backfires of unsound expansion or doubtful applications; too much is at stake.

Since this is officially, and behind the scenes, the attitude of the American Welding Society, it deserves the active support of the users of welding in all industries.

Consistency in Fuel Purchases Is Reflected in Steam Costs

WHEN pulverized coal burning was a comparatively new thing, common opinion was that anything that would burn could be used as fuel by this method. Unfortunately, this theory was often acted upon and the consequent poor results blamed on the equipment instead of the fuel. In the face of the fact that good operation can be obtained only by determining the best conditions and then holding as nearly as possible to them, fuel quality has often been changed for a few cents advantage, regardless of the greater over-all loss thus caused.

An interesting example of the value of consistency in fuel purchases recently came to light. A certain large industrial plant installed unit pulverizer equipment on two of its boilers in the early days of such equipment.

The first move made was to test various coals with this equipment until one was found that gave good results with the burners and furnaces installed and yet did not cause undue wear on the pulverizer. This coal has been used ever since, and, as a consequence, the equipment has given thorough satisfaction, while other users of the same design have had trouble with their burners and pulverizers and have also failed to realize the maximum economy of their equipment. Investigation shows that these latter plants have all shifted from one coal to another too frequently to allow conditions to become sufficiently stabilized to give good results.

While this example of the value of consistency in fuel purchasing deals with pulverized fuel, instances might also be given to prove the same thing for stokers and hand firing.

Cost of steam produced is the measure by which a plant should be judged. A coal should be chosen that will make this steam cost as low as possible, regardless of the cost per ton of the fuel. And this coal should then be adhered to, except in cases where an absolute emergency or an undue rise in price makes it necessary to change.

A Rational Boiler Factor of Safety

SHOULD operating conditions be recognized as a factor in establishing the safe working pressure of a boiler, is a question answered in the affirmative by C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association, in his annual report.

Regulatory bodies and even the boiler insurance company examine closely the character of the metal used in the shell and tubes, insist on the designer's using a proper system of riveting and bracing and rigid inspection of workmanship at the boiler shop. Once built, the boiler is assumed to be good for a definite working pressure regardless of its service.

The engineer who observes due care in cleaning the boiler of scale, in keeping the supports properly adjusted and in maintaining a tight setting receives no preferment over the slipshod operator, in respect to working pressure. True, the boiler inspector may make recommendations as to improvements, but these are issued on a take it or leave it basis. The boiler is either left insured or the insurance is canceled. While a pressure reduction on account of operating conditions may occur, the action is notable by its absence.

Other hazards beyond the immediate control of the engineer exist. Certainly, a boiler using a clean noncorrosive or non-scaling water could safely carry a pressure beyond that judiciously permissible in a boiler fed, with a water of a high mineral content.

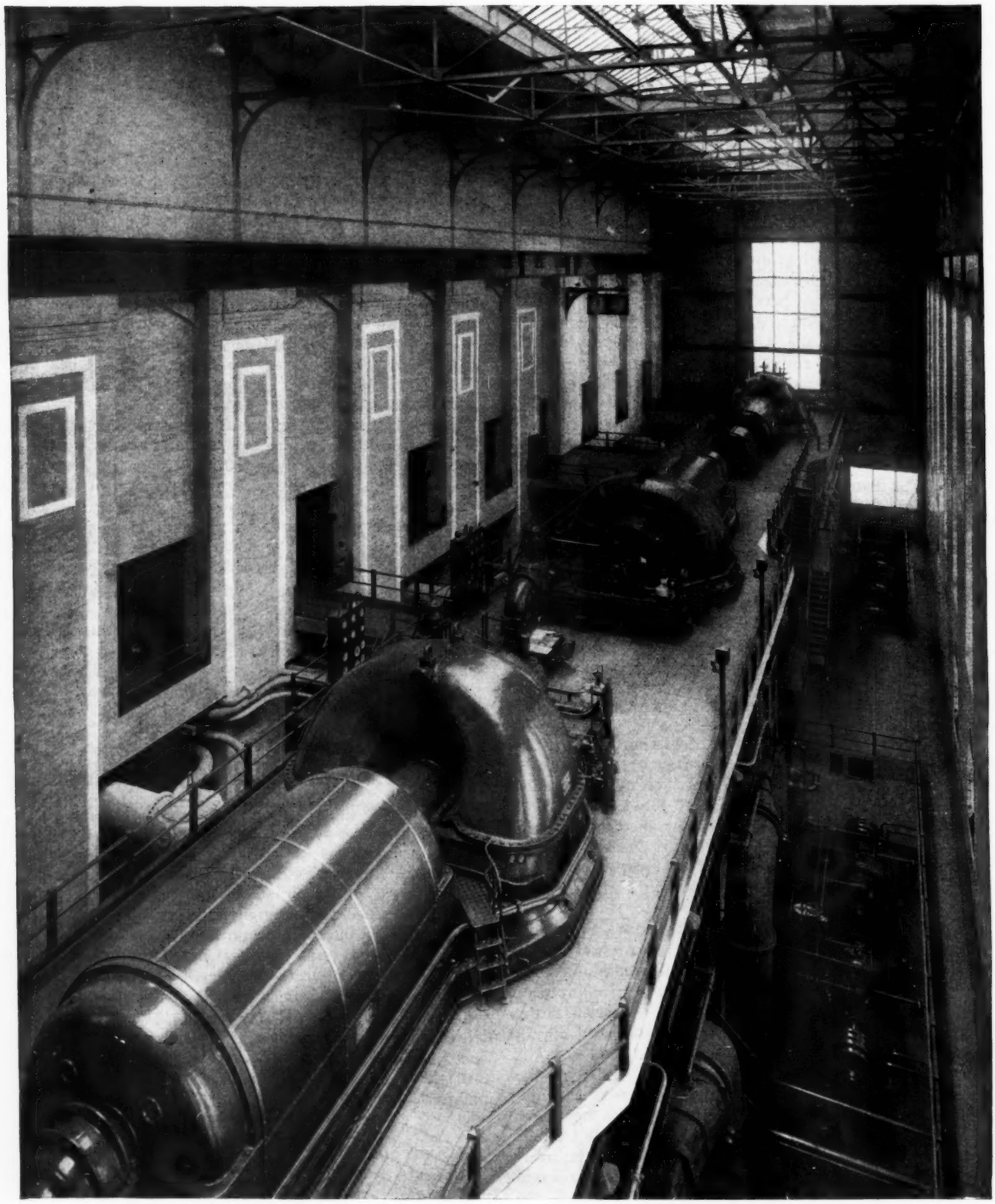
Why Exclude Manufacturer's Experience?

EQUIPMENT in the power field falls into two classes—that which is self-contained and that which is circumscribed in design by plant layout. Too often, builders of the latter class are not called into the picture early enough to permit advantage being taken of their judgment gained through long and specialized experience. The result is usually a compromise in design which meets neither the full expectations of the customer nor satisfies the pride of the builder.

Anyone who has had experience in construction work will recall instances of chagrin at the architect for working too far ahead of the engineer. Recollection of such instances may perhaps lead to a more co-operative attitude on the part of the engineer toward the equipment builder.

WHILE SOME INDUSTRIAL may have wide enough requirements to justify its ownership of coal mines, this is not generally true. While coal may cost close to two dollars a ton to mine, screenings can be procured for sixty cents a ton, the difference between cost and sale price being made up by the mine's profit in the larger prepared sizes sold for domestic and railroad uses.

Story of First Commercial



The main turbine room contains two 32,000-kw. units in the foreground and a 65,000-kw. unit in the background

1,200-Lb. Steam Plant

Why this pressure was chosen

Operating experiences at Edgar Station

Results that have justified the decision

By I. E. MOULTROP*

Chief Engineer, The Edison Electric Illuminating Company of Boston

THE real reason for our building a 1,200-lb. steam plant was the belief, backed by conservative estimates of the cost of construction, that we could save enough coal to pay us a handsome profit on the money invested. In other words, we were after dollar efficiency and not thermal efficiency alone.

Fig. 1 shows what has been accomplished in the last fifteen years toward increasing the thermal efficiency of steam-electric generating stations. The period since the War has been one of accomplishment of which all should be proud. The B.t.u. required to generate a kilowatt-hour has been reduced approximately 30 per cent. In fact, we are approaching what seems at this time to be the maximum practicable possibilities of the steam cycle.

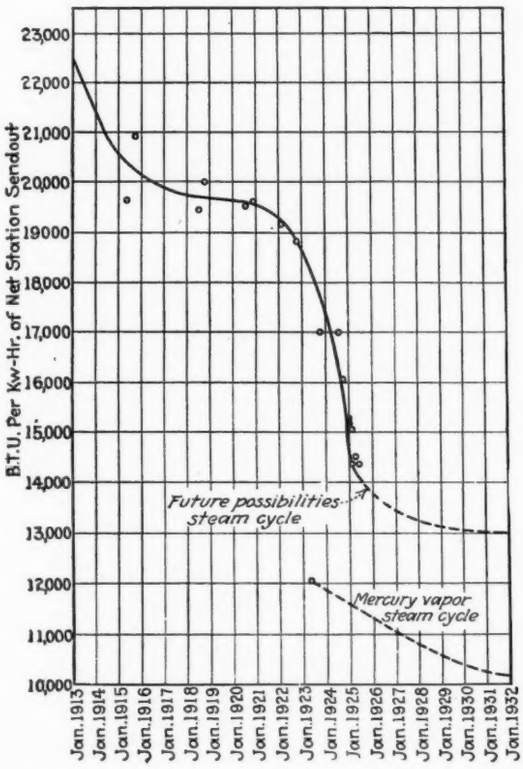


Fig. 1—Performance of typical stations of 60,000-kw. capacity and greater

Fig. 2, curve 5, shows that the result of the increase in thermal efficiency has been a decrease in the total cost of power generation. Curves 3 and 4 show, however, that this reduction has been due to coal saving alone. Curve 4 shows that the fixed charge cost of generating has not been reduced along with the coal cost. Consideration should be turned from thermal efficiency to dollar efficiency. If attention is focused on the problem of reducing the cost of construction with the same enthusiasm that has been shown in pursuing the elusive B.t.u., much can be accomplished toward further reducing the cost of generation.

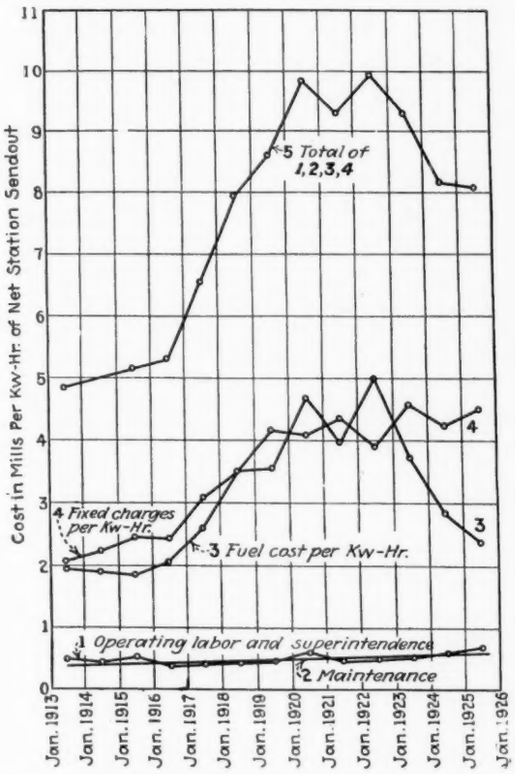


Fig. 2—Trend of operating costs and fixed charges for typical stations of 60,000 kw. and greater

When we came to design the Edgar Station,[1] we made an exhaustive study of the possibilities of various steam pressures and temperatures. It was found economical to use steam at as high a temperature as possible irrespective of the pressure. The materials available for

*Mr. Moultrop delivered the paper, on which this is based, as an illustrated lecture before the Engineering Institute of Canada and the Philadelphia Section A.S.M.E.

[1]Described in detail in *Power*, April 14, 1925.

construction show a decided falling off in strength at temperatures above 750 deg. F., and for the sake of safety we decided to use a steam temperature of about 700 deg. for the initial installation. We expected to go to a higher temperature just as soon as suitable materials were available at reasonable prices.

We next studied the question of pressure and found that for a station employing the regenerative cycle, but no reheating, there appears to be no economic justification in going to pressures higher than 350 lb. at the turbine throttle. For pressures much higher than this the studies indicated that for our conditions the coal saving would not justify the additional cost of construction.

Regenerative Cycle Made 1,200 Lb. Worth While

When we studied the problem from the viewpoint of the regenerative reheat cycle, however, a decided advantage was found in raising the throttle pressure to somewhere between 1,200 and 1,500 lb. In fact, the studies indicated that we could probably obtain a net coal saving of 12 per cent by raising the throttle pressure from 350 to 1,200 lb. if we would reheat the steam at about 350 lb.

Fig. 3 shows the B.t.u. per kilowatt-hour possibilities in the turbine room for several pressures and temperatures. On the left are comparisons for stations that do not extract steam from the main turbines for heating the feed water, and on the right the comparison on the basis of extracting steam to heat the feed water to a temperature of 340 deg. F. There is a chance of obtaining an improvement of 14.9 per cent by going to 1,200

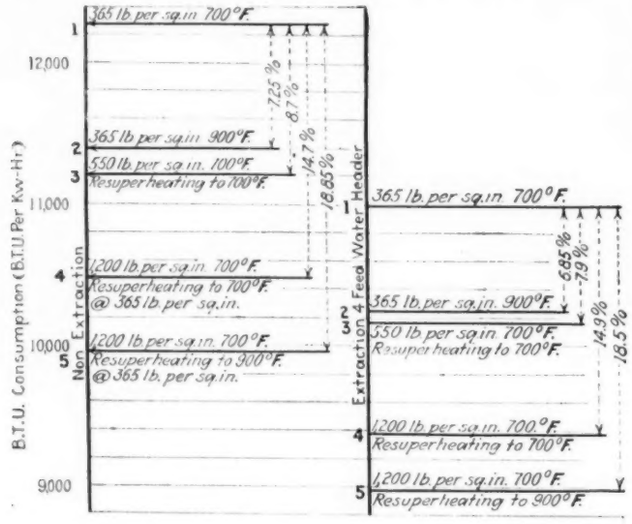

B.T.U. Consumption (B.T.U. Per Kw-Hr.)
12,000
11,000
10,000
9,000
Non Extraction
Extraction 4 Feed Water Heater
1 365 lb. per sq.in. 700°F.
2 365 lb. per sq.in. 900°F.
3 350 lb. per sq.in. 100°F. Resuperheating to 700°F.
4 1200 lb. per sq.in. 700°F. Resuperheating to 700°F. @ 365 lb. per sq.in.
5 1200 lb. per sq.in. 700°F. Resuperheating to 900°F. @ 365 lb. per sq.in.
7.25%
8.7%
14.7%
18.65%
1 365 lb. per sq.in. 700°F.
2 365 lb. per sq.in. 900°F.
3 350 lb. per sq.in. 700°F. Resuperheating to 700°F.
4 1200 lb. per sq.in. 700°F. Resuperheating to 700°F.
5 1200 lb. per sq.in. 700°F. Resuperheating to 900°F.
6.85%
7.9%
14.9%
18.5%

Fig. 3—Comparison of B.t.u. consumption of various cycles at their best loads (1 in. abs. back pressure, final feed temperature for extraction cycles = 340 deg. F.)

lb. and reheating. When this is corrected for additional auxiliary power, etc., a net improvement of about 12 per cent can be expected. Fig. 4 shows segregated costs of a steam-electric generating station. Many are of the opinion that the cost of a high-pressure station is too great to be justified by the coal saving. To satisfy these "doubting Thomases," let us analyze the cost of a steam-electric generating station and see what are the various items affected by pressure costs as compared to the whole. In this way the total effect can be estimated.

Since a high-pressure boiler will produce more power than a boiler of the same size operating at normal pressure at the same rating, it is obvious that the cost of the main buildings, the preparation of site, coal and ash-handling equipment, etc., will be less per kilowatt of generating capacity. Since the turbine-generating unit will use less steam per kilowatt-hour, it is also obvious that the cost of the condensing plant, including the

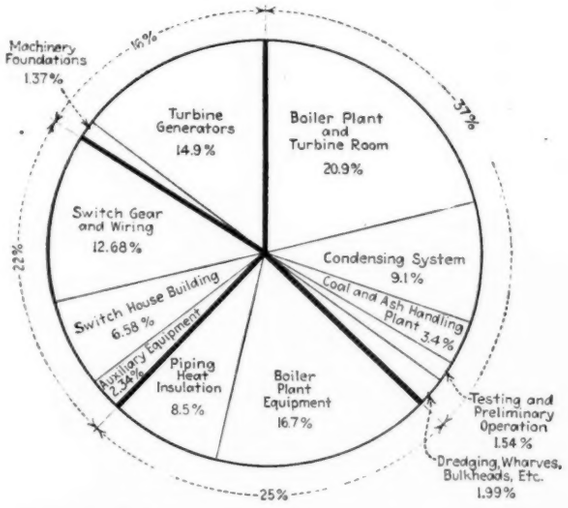


Fig. 4—Relative costs of various parts of station

intake and discharge tunnels, will be less. The turbines and their foundations will cost more for the high-pressure equipment. The switchhouse, switch gear and wiring, and auxiliary equipment should cost about the same. In the boiler plant the pressure parts will cost more money, while those parts that are not subjected to pressure will cost less.

Station Planned for Convenience

This, in general, is the picture. The summary of these costs shows that the cost per unit of station capacity is about the same for a 1,200-lb. as for a 350-lb. plant. plant.

Taking all these factors into consideration, we went ahead with a first-class 350-lb. station consisting of two 32,000-kw. turbine-generator units and three 425-lb. boilers. Outside of the question of pressure the design of boiler plant was particular to the stations of The Edison Electric Illuminating Company of Boston. By placing the stokers in the outside aisles, the major work of the boiler-room operators is confined to one central aisle. In this aisle are the instruments for controlling the operation of the boilers, and the boiler-room engineer can supervise the operation of the boilers with the minimum amount of moving around. He can keep in touch with what is going on much better than if the controls were located in several aisles.

The two outside aisles are closed off from the central aisle, so that the operating aisle can be kept clean. The roof over the operating aisle is of glass, so that the men work in a sunlit, cheerful room instead of the dark aisles so often found in large boiler plants.

The first 1,200-lb. boiler contains 15,732 sq.ft. of water evaporating surface. The tubes are 2 in. outside diameter and are 15 ft. long. The superheater is located interdeck above the seventh row of tubes, and the 375-lb. reheater for the exhaust of the high-pressure turbine is above the tubes in the first pass. There is a movable

baffle in the gas path through the reheater that permits regulation of the outlet steam temperature. So far we have found it unnecessary to use this feature.

The boiler is fired by a 15-retort, 29-tuyere underfeed stoker. By reason of the short boiler tubes it was necessary to use an arch over the front of the stoker to get in a stoker of sufficient length. Unfortunately, we installed an inclined arch at a wrong angle. The reflection from this arch overheats the rear wall unless we operate with higher excess air than desirable. We believe that we would not have had this trouble had the arch been horizontal.

The boiler drum was made from a solid forging. It is 48 in. inside diameter, 4½ in. thick, and weighs 96,000 lb. I honestly believe that it is the safest boiler drum we have in the station. If it were not for the cost, that is how I would like to have all boiler drums made irrespective of pressure.

As this was the first commercial 1,200-lb. boiler ever built, we visualized many possible troubles. As it turned out, practically every trouble that we looked for failed to materialize. No one had had any experience with safety valves at this high pressure, and we were afraid that when the safety valves operated, they might destroy their seats. To guard against this, we installed two small safety valves with shutoff valves between them and the boiler. These were set at a pressure below the setting of the main valves. We thought that these would give warning of approach to the blowing pressure of the main valves, and we could then take steps to reduce the pressure and prevent the main valves from lifting. We actually found out that the main valves operate just as satisfactorily as normal pressure safety valves and do not destroy the seats. We have been able, therefore, to dispense with the small valves and operate the boiler nearer the pressure at which the main valves are set.

We have had a lot of trouble with steel castings in the past, at 200 and 300 lb. To be sure of sound castings for the 1,200-lb. pressure, we examined all castings by means of an X-ray. Some were found porous and rejected. As a result no trouble was had with steel castings operating at 1,200 lb. Some trouble has been experienced with the castings for the 350-lb. part of the station, which were not examined by X-ray.

Not knowing how the water level in the 1,200-lb. drum would act, as no one had manufactured feed-water regulators for this pressure, we arranged for hand control of the feed water. But we have found that the water level in the 1,200-lb. drum is just as steady as in the 425-lb. boilers and have equipped the 1,200-lb. boiler with feed-water regulators which are now operating satisfactorily.

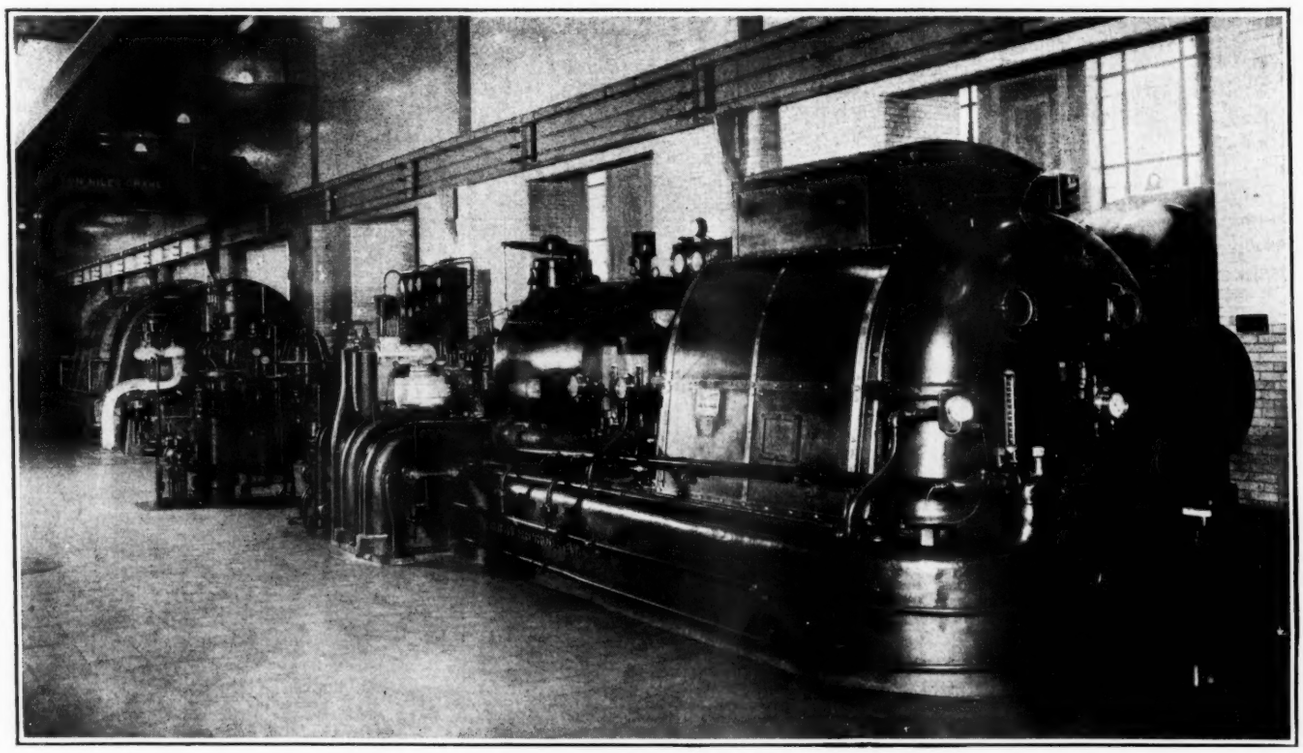


Fig. 5—The two high-pressure turbine units

The only thing that has happened to the 1,200-lb. boiler out of the ordinary is the warping of the tubes exposed to the radiant heat of the furnace. Many of these have warped, but some in one direction and some in another. They did not fail, and now the warping seems to have stopped. Also, we experienced slagging over of the lower row of tubes. This is due to too close spacing of the tubes exposed to the furnace and to stoker and furnace operation.

The 3,150-kw., 1,200-lb. turbine installed in connection with this boiler is a 20-stage, 3,600 r.p.m., General Electric machine. It was not known whether the governing characteristics would be such that the turbine could be synchronized easily. Therefore the generator field was designed so that the turbine could be brought up to somewhere near synchronous speed and the generator put on the bus as an induction generator.

When the turbine was finally installed it was found to

respond to the governor just as well as any normal pressure turbine, but the special field was the cause of some vibration. The manufacturer, therefore, replaced the special field with one of standard design and the vibration troubles were cured.

Carbon shaft packing was originally installed outside the labyrinth packing. This packing failed before the machine was placed in commercial operation and was replaced with labyrinth packing, and no further trouble has been experienced. The thrust bearing was found to be too small and was replaced with a larger one, and has since operated satisfactorily.

The radial diaphragm packing was damaged when the carbon packing failed, and it has been replaced with axial packing.

In May, 1926, after 1,600 hours of service, the turbine was opened up for inspection. In general the interior of the turbine was as might be expected of a normal pressure turbine with the following interesting exceptions:[2]

The first two rows and the last two rows of buckets on the rotor were bent in as if they had come in contact with some hard object. The nozzles were not injured nor were the other sixteen rows of buckets. So far no satisfactory explanation of this trouble has been advanced. The buckets were trued up and the turbine has operated satisfactorily ever since.

Another thing discovered was that the whole interior of the casing and the buckets was covered with a light deposit of iron oxide. This deposit was also found in the valves, fittings and all the boilers in the station, both normal pressure and high pressure. In certain spots this deposit was built up in little mounds, and when these were removed evidence of the start of pitting was discovered.

[2]An account of these, with photographs, was published in *Power*, June 15, 1926.

Taking the plant as a whole, none of the troubles experienced has been due to the pressure.

In 1926 it became necessary to start an extension to the Edgar Station. In the light of our experience with high-pressure equipment we made an exhaustive study to determine the proper pressure for the extension. Three plans were studied: (1) All 350 lb.; (2) all 1,200 lb.; (3) one-half 1,200 lb. and one-half 350 lb.

This study showed that the second plan, all 1,200 lb., would give the lowest cost per kilowatt-hour on the station bus when all things are considered. It appears at this time that all boilers in the extension of this station will be built for a maximum working pressure of 1,400 lb. per square inch.

We also considered going to a steam temperature of 900 deg. F. The turbine manufacturers assured us that they could build a turbine for any temperature steam that could be delivered to the throttle. The problem of handling steam at higher temperatures in the turbine, however, is far simpler than that of designing superheaters to deliver the steam. With first-pass gases on one side and very hot steam on the other, the superheater tube is subjected to severe service. However, the investigations of the characteristics of metals at elevated temperatures are bound to produce in time a metal or alloy which will be suitable for the service and salable at a price that will make it economically justified.

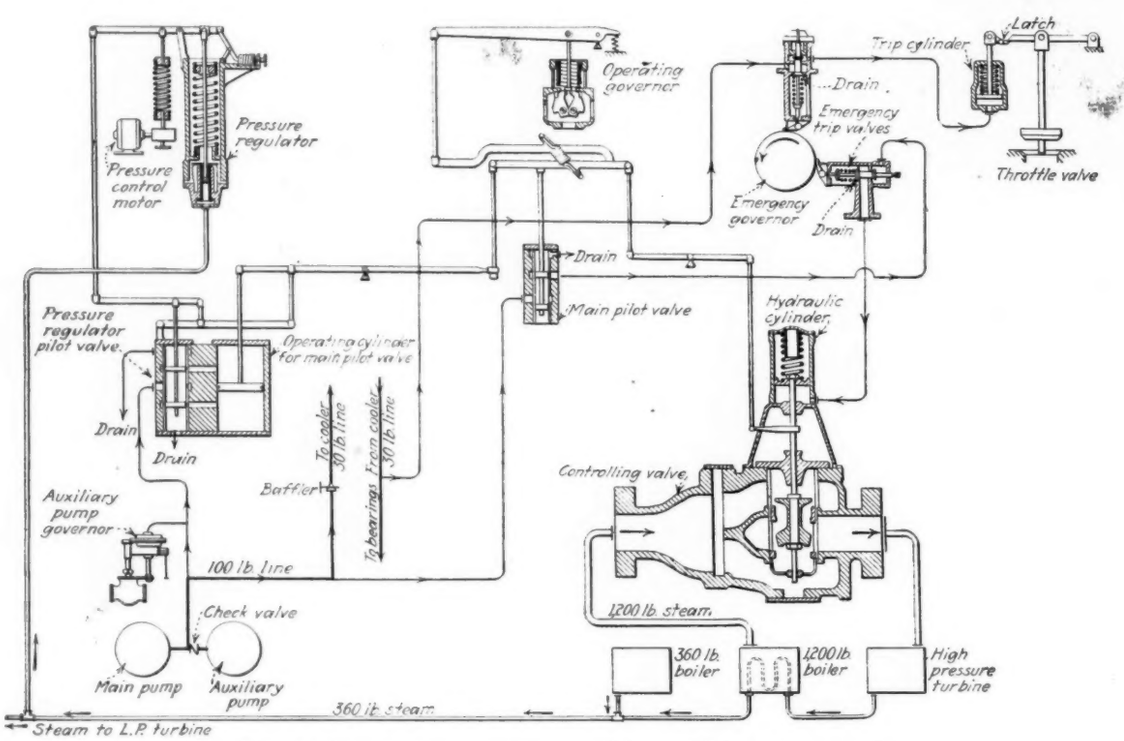


Fig. 6—Governing arrangement of latest high-pressure unit

Ready For Higher Temperatures

Superheater manufacturers are ready to supply superheaters designed for a temperature of 900 deg. F., but they are frank in saying that we must expect to go through some operating troubles, the seriousness of which they cannot definitely predict.

The valve and fitting manufacturers assure us that they can safely handle steam at 1,000 deg. F. Station designers in the United States, however, seem to feel

that 750 deg. F. is about the limit at this time. They feel that those who have gone beyond this limit have not given due consideration to the characteristics of the materials being used when maintained at the high temperatures over long periods.

When it came to the purchase of the two boilers for the extension to the station, it was found that the thickest steel plate that could be forged into headers by the Babcock & Wilcox Co. would give a safe working pressure of 1,400 lb. per sq.in. As this additional pressure could be obtained at little increase in cost, the new boilers were designed and built for this pressure.

As mentioned previously, the first high-pressure boiler was built with 2-in. tubes throughout. It was found that the tubes were spaced too closely and resulted in slag bridging across between the tubes next to the furnace. The new boilers have eight rows of $3\frac{1}{4}$-in. tubes in the lower bank spaced $8\frac{1}{4}$ in. center line to center line, giving a space of 5 in. between tubes. No trouble with slag has been experienced with these boilers. The upper bank of tubes is made up of 2-in. tubes and is 10 tubes in depth. We also found it possible to use 19-ft. $3\frac{1}{4}$-in. tubes, and 18-ft. 2-in. tubes instead of the 15-ft. tubes used in the first boiler. The new boilers each contain 15,093 sq.ft. of water evaporating surface. The superheaters are located the same as in the first boiler, but are designed for higher outlet steam temperature. The 1,200-lb. superheater is designed for an outlet temperature of 725 deg., and the 375-lb. reheater for an outlet steam temperature of 750 deg.

A 5,596-sq.ft. economizer and a 32,032-sq.ft. air heater have been installed in connection with each of the new boilers. The air heater is designed to give an air temperature of 400 deg. F., but the stoker is designed for a maximum air temperature of 600 deg. A bypass for the economizer has been installed so that the performance of the stoker with air temperatures in excess of 400 deg. can be studied.

The first high-pressure boiler was fired by a 15-retort, 29-tuyere Taylor underfeed stoker and has a continuous capacity of approximately 121,400 lb. of steam per hour. The new boilers are fired by 16-retort, 45-tuyere Taylor stokers and are designed to generate 270,000 lb. of steam per hour continuously. These stokers are the largest underfeed stokers in service today.

Some trouble has been experienced with the refractories in the furnace of the first high-pressure boiler, and this has necessitated operation with higher excess air than desirable. With the use of preheated air and such high heat liberation per cubic foot of furnace volume, the problem of a satisfactory refractory furnace seems hopeless, and so the new furnaces are provided with water-cooled refractory-faced Bailey water walls on the side and rear walls.[3] The front walls are Bigelow hung walls ventilated in the rear.

In the extension to the station we have installed a 10,000-kw. high-pressure and a 65,000-kw., 350-lb. General Electric Co. turbine-generator unit. Both these units are of special interest. The 10,000-kw. high-pressure unit is the largest 1,200-lb. unit in the world, and the 65,000-kw. unit is the largest single-barrel single-flow 1,800 r.p.m. unit.

Fig. 5 shows the two high-pressure turbine-generators, the 10,000-kw. unit being in the background. It is not much larger than the 3,150-kw. unit which appears in the foreground.

The casing of the new turbine is of forged steel, while that of the first turbine was of cast steel. The new turbine has sixteen stages instead of twenty and will have a 4 per cent better water rate than the first one. It is equipped with water-sealed glands outside the labyrinth packings on both the high-pressure and exhaust ends of the shaft.

How New High-Pressure Turbine Is Governed

Governing of the new high-pressure turbine presented a problem that was much more difficult than when there was only one boiler and one turbine. The design adopted after careful study is shown in Fig. 6. The turbine will be brought up to speed and synchronized by means of a speed-actuated governor of standard design. After the turbine is on the line, a pressure-actuated governor will be put into operation and the speed-actuated governor set for some speed above 3,600 r.p.m., when it will act as an emergency governor. The pressure-actuated governor will control the load on the high-pressure turbine so as to maintain a constant pressure in the 360-lb., 725-deg. header supplying steam to the 350-lb. turbines.

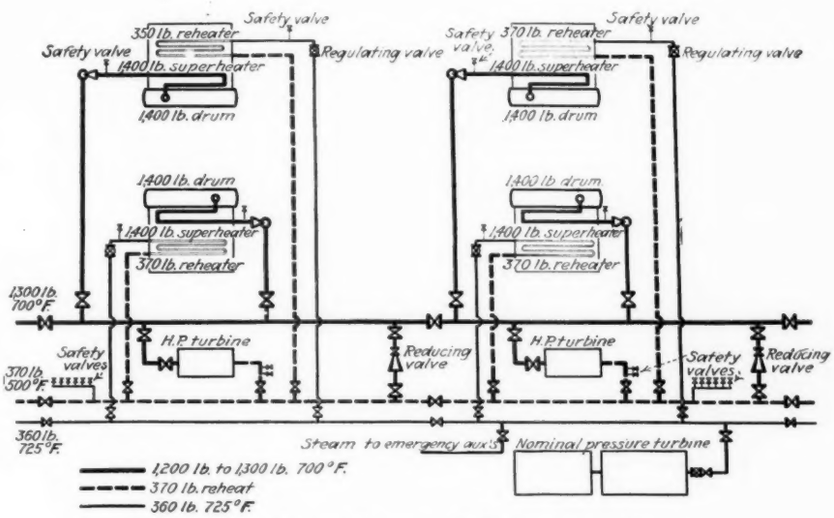


Fig. 7—Piping diagram of Edgar extension

The problem of piping up several high-pressure boilers and their reheaters in parallel is considerably more complicated than that of a single boiler and turbine. Fig. 7 shows how the new boilers and the high-pressure turbine have been piped. There is a reducing nozzle between the 1,200-lb. header and the reheat header. If the high-pressure turbine is out of service, the steam can be expanded through this nozzle and the boiler kept on the line.

This system of piping is rather expensive and we hope in the future extensions to simplify it materially and thereby reduce the cost.

For all high-pressure pipe joints we have used the "Sargol," and have had no trouble.

The problem of pumping sufficient boiler feed water

[3]For an account of water wall troubles in the high-pressure boilers of the second unit see *Power*, March 13, 1928.

for a load of 85,000 kw. to a maximum pressure of 1,600 lb. per sq.in. is one that has never before been encountered in steam-electric generating station design. To accomplish this, three boiler-feed pumping units of interesting design have been installed. Two are motor-driven and will be used for normal operation. The third is turbine-driven and will be used for emergency service. Each unit has a capacity of 900,000 lb. per hour.

Each of the motor-driven units consists of four pumps in series. The first two pumps of each unit are piped in series and are driven by a 625-hp. motor. The second pump of this unit delivers water at a maximum pressure of 500 lb. per sq.in. and pumps through the high-pressure bleeder heaters to the suction of the third pump.

The third and fourth pumps are piped in series and are driven by a 2,030-hp. motor. The 625-hp. motors are regulated to maintain a constant discharge pressure. The 2,030-hp. motors are regulated to maintain a constant differential between the discharge pressure and the pressure in one of the boiler drums.

The turbine-driven boiler-feed pump is designed to operate at a maximum speed of 3,570 r.p.m. and pumps the water from approximately 50 lb. to 1,600 lb. in one casing. The turbine is differentially controlled and is also arranged for automatic starting when the pressure in the 1,600-lb. boiler-feed headers drops below a set pressure. The turbine is rated at 2,450 hp. This boiler-feed pump is the largest one in the world by far, from the viewpoint of the power required to drive it.

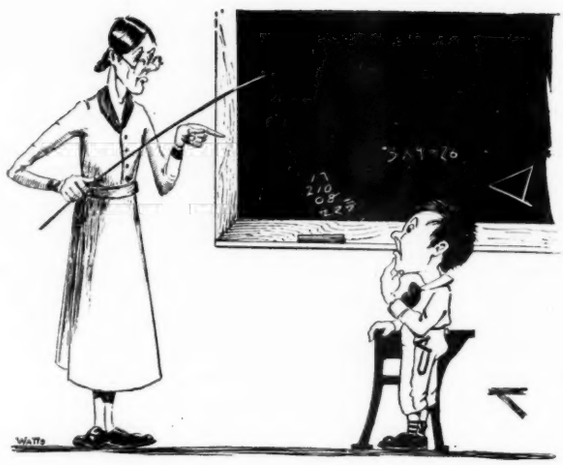
A study of the heat balance of the extension showed that it was economical not only to bleed the 350-lb. turbine at three points, but also to bleed the exhaust of the high-pressure turbine for heating the feed water. This means that steam at approximately 370 lb. will be used for heating the feed water. The heater is designed so that water at approximately 420 deg. will be fed to the economizers. So far as we know, this is the highest steam pressure used for this purpose.

Why Live-Steam Heater Was Not Used

Some may wonder why we do not use the 1,200-lb. steam in a live-steam reheater to reheat the steam from the exhaust of the high-pressure turbine. The reason for this is that the saturation temperature at 1,200 lb. is about 570 deg. F. If we used a live-steam reheater and delivered the 350-lb. steam to the normal-pressure turbines at 570 deg., we would lose in economy practically all that was gained by going from 350 to 1,200 lb. There is a real possibility, however, that we can use to advantage a live-steam reheater and a tandem-compound 350-lb. turbine in extensions to the station. This possibility will be studied when we come to install the next 350-lb. turbine.

As to the growth of the use of 1,200 lb. pressure in the United States, there is now in service 50,830 sq.ft. of boiler surface operating at 1,200 lb. or higher. There is also in service 20,150 kw. of turbine-generator capacity for this pressure. In addition to this, there is 17,000 kw. of turbine-generator capacity on order and no doubt boilers for these units are also on order.

I believe that the most important facts brought out by the present high-pressure installations in the United States are that in a properly designed station the high pressure does not decrease flexibility nor incur any serious operating difficulties; furthermore, a high-pressure plant of the proper design need not cost any more per unit of generating capacity than a low-pressure plant and will show a substantial improvement in thermal efficiency.



WHAT DO YOU KNOW?

By L. H. Morrison

The answers are on page 725

Ques. 1—In a tug of war the men in one team weigh a total of 1,000 lb., while the second team weighs 1,400 lb. The heavy team, as would be expected, outpulls the lighter men. What is the difference in the force exerted by the two teams, and why can one team outpull the other?

Ques. 2—What is the difference between a steam and a hot-water radiator?

Ques. 3—Are large furnaces necessary to obtain high boiler efficiencies?

Ques. 4—What height of furnace would you recommend for a fire-tube boiler burning Kentucky 40 per cent volatile coal, hand-fired?

Ques. 5—What is a "therm"?

Ques. 6—When is the National Meeting of the Oil and Gas Power Division of the American Society of Mechanical Engineers to be held?

Ques. 7—Which is the more efficient, a steam air jet or a rotary vacuum pump for condenser-air removal?

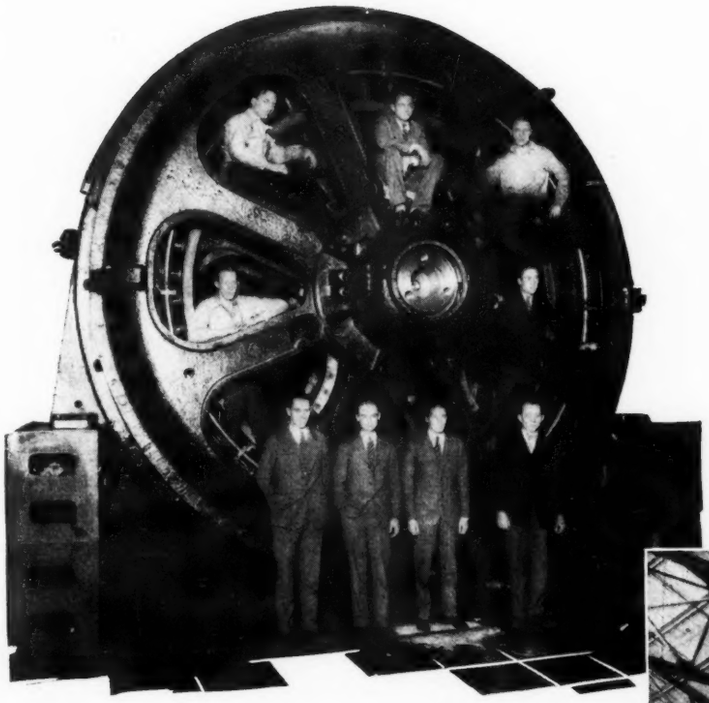
Ques. 8—Can you run a pump as fast when handling hot water as when handling cold water?

Ques. 9—Why should not a centrifugal pump impeller be kept in motion while the pump is being primed?

Ques. 10—If your boiler had two safety valves and the working pressure was 200 lb., at what pressure would you set the valves to relieve?

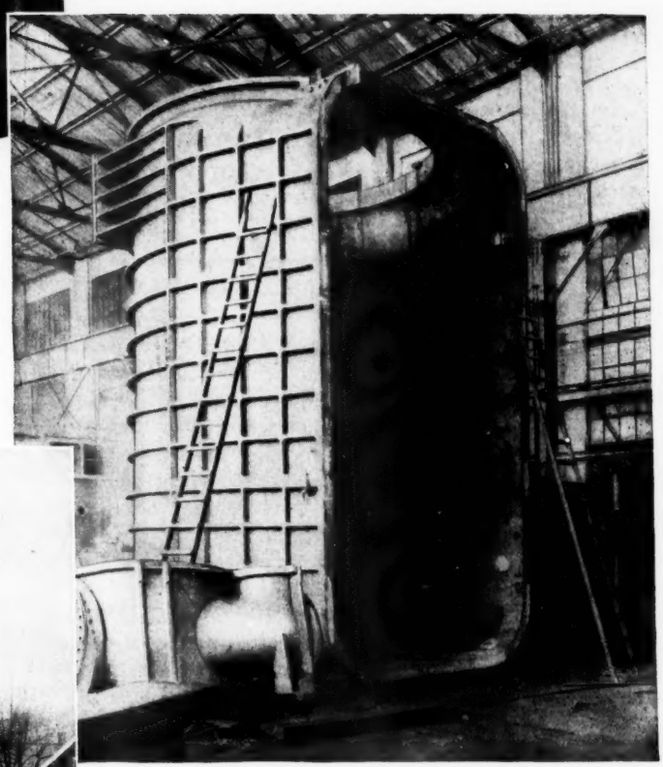
ON WITH PRODUCTION!

Down goes the hydraulic service on a 3,000-ton press—and down into the pit goes the engineer to solve the knotty problem. This story, in an early issue, will be followed by others of vital interest to the men who must keep alive the power services to production.



Left—One of the General Electric 3,700-volt propulsion motors of the turbine-electric passenger liner "Virginia." There are two of these motors, one on each propeller shaft. They are of the synchronous-induction type and are rated at 8,500 hp. at 120 revolutions per minute

Below—Shell for a 50,000-sq.ft. single-pass Foster-Wheeler condenser to be installed on a 60,000-kw. turbine in the Pekin plant of the Superpower Company of Illinois.



On Land and Water

Photo by courtesy of the Boston Edison Electric Illuminating Company

Left—Far above the house tops is this transformer, which is rated at 18,000 kva. and weighs 64 tons. It was unloaded from a freight car on the high ground at the left and moved out over its foundation, where it is now ready to be lowered into place

Transmitting and Applying
MECHANICAL POWER

By Graham L. Montgomery
Editorial Staff Power

Transmission and application of mechanical power is such an important part of the load of most industrial power plants that the power engineer cannot afford to neglect studying it. Also, more and more, the supervision of these power services is being assigned to power engineers. In this, and succeeding articles to be published from time to time, the more important general aspects of the selection and operation of power transmission systems and equipment will be discussed.

TRADITION, even in a country like the United States, which prides itself upon its industrial progressiveness, is responsible for much divergence of opinion as to what equipment will best do a given piece of work. This is particularly true in the field of the transmission and application of mechanical power. Almost every device that has ever been designed for this purpose may still be found in use and has its ardent advocates. Direct-connected, slow-speed engines; rope drives; shafting and belts driven by a single motor or engine; group drives consisting of a number of motors, each driving by belt or chain a group of several machines; and individual motor drives, are all common practice today. And in the last class the means of applying the motor's power to the machine include direct connection, gearing, belting, rope drive, chain drive and friction drive. With these individual drives the motor may be mounted on the wall, floor or ceiling of the factory, or on a base provided on the machine itself, depending on the machine to be driven.

It is interesting to note that the popular idea of individual drive considers it to mean direct connection. This is far from true, for the majority of individual drives transmit the power to the machine through gearing, chains or belting. Machines that can be direct-connected to motors are rather few, because suitable motor speeds are not available; and in case the speed is low, the relatively high cost and lower efficiency of the motor makes direct connection too costly. By low speed, in this case, less than 1,000 r.p.m. is meant. Individual drive simply means using a separate motor for each machine. One large metal-working plant uses a single electric motor to drive all the machinery in each department. These motors are each belted to a single lineshaft, which in turn drives many countershafts by means of belts. Each of these countershafts drives one or more machines belted to it.

Many plants use slow-speed engines directly connected to the machines. Blooming mills of this type are common. Wood for dye and drug extraction and for pulp manufacture is often chipped in machines so driven. Numerous other examples will occur to anyone who has visited many industrial plants.

Extensive systems of rope drive are today infrequent. But there are a number of textile mills, some mines and at least one steel mill that still transmit and apply their power by this means.

Group drives are extremely common and very popular.

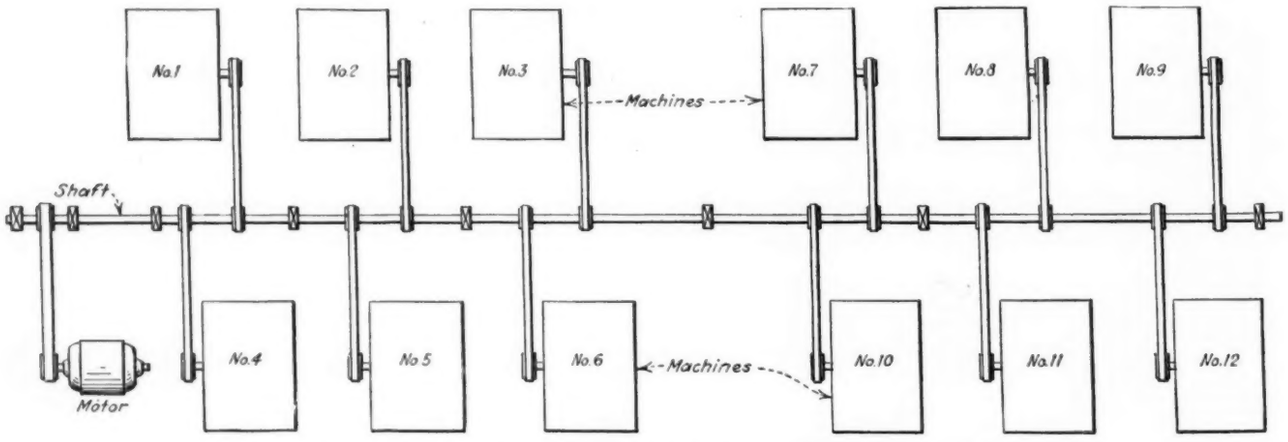


Fig. 1—Group of twelve machines run from a single motor and lineshaft

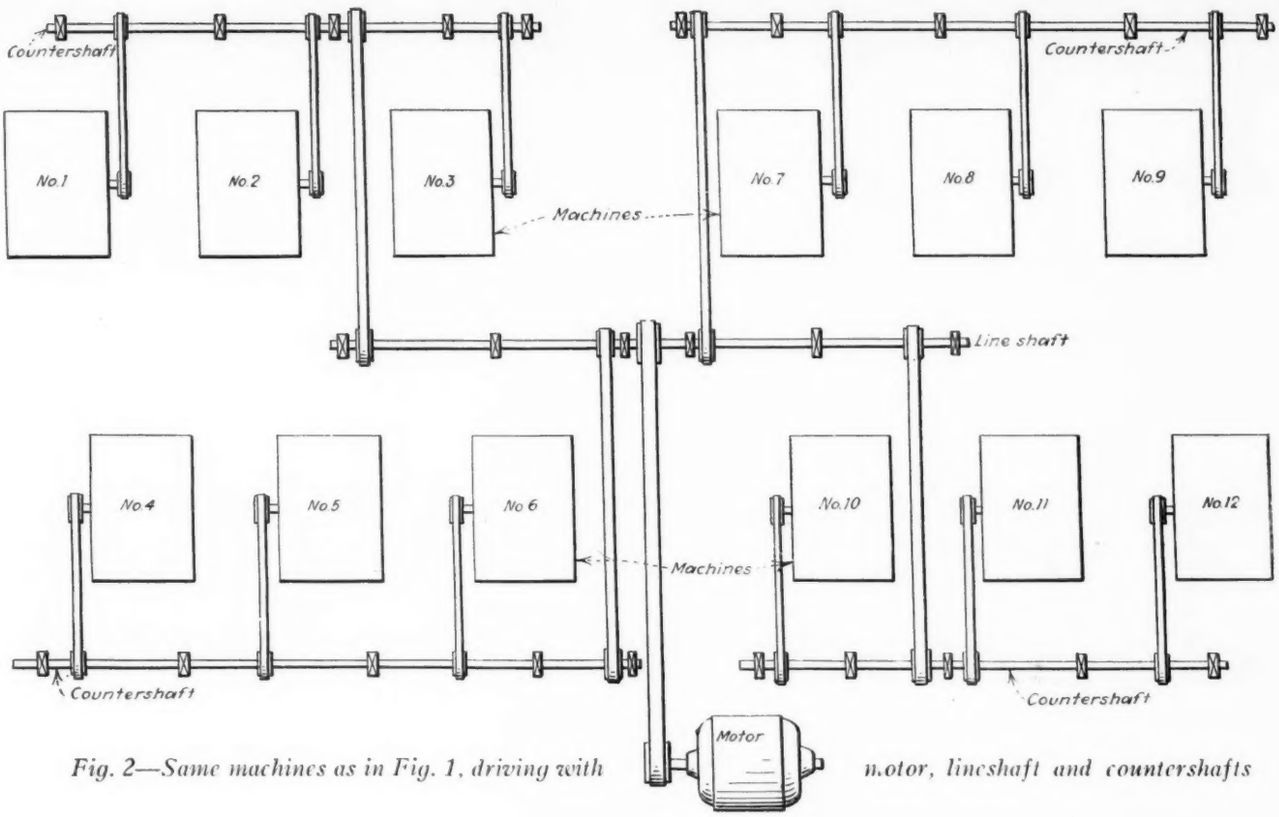


Fig. 2—Same machines as in Fig. 1, driving with motor, lineshaft and countershafts

A single department of a factory often has several groups of machines, each group consisting of several machines of similar design, speed and power requirements. One motor will be used to drive each group—shafting, pulleys and belts, or shafting, sprockets and chains transmitting the power to the individual machines. Examples of this method will be found in every industry.

Individual motor drive is, however, the most common system today. Modern plants that operate with a comparatively few pieces of equipment, each of large capacity, such as rubber tire plants, chemical plants and bread bakeries, are almost all equipped in this manner. On the other hand, plants containing many similar machines, each of relatively small capacity, such as weaving and metal working plants, are now largely equipped in the same manner. Shops that fall between these two classes are likely to use group drive, but many use individual drive, depending on the layout.

It is apparent from a study of the new plants that are now being built that engineering opinion today favors the group and individual drive systems to the exclusion of the other and older methods. This choice can be easily justified, in spite of the few but outspoken supporters of the other three systems.

The most important objections to the slow-speed, direct-connected engine are the high first cost and the inflexibility of the installation. There are other less important objections, but these two are sufficient to overcome its advantages of reliability and low maintenance cost. It is also a fact that much greater economy can be obtained in other ways.

The rope drive suffers under the same disabilities of high first cost and inflexibility as the direct-connected engine. In addition it requires considerable space and much maintenance. Compared to belts for the transmission of large powers, it has a higher efficiency at somewhat less cost. For the transmission of smaller powers the positions are reversed.

To drive a shop from a single motor, by means of lineshaft and countershafts, means that the motor must be large enough to carry the full load of the shop. Since it is seldom found that more than half of such a load will be in use at any one time, a large and expensive motor has been installed to do work that could be done by several smaller ones of less aggregate horsepower and generally less first cost, because of the higher over-all load factor that can be obtained with the smaller motors. Also the large motor, running largely at low loads, does not operate so efficiently as do the smaller motors.

Using a single motor in this manner necessitates shutting down the whole shop when maintenance work or repairs are necessary. It also means much troublesome maintenance of shafts, hangers and belts, in particular when the shaft becomes misaligned from unequal loading, as it frequently does. There are other less important disadvantages that need not be mentioned, and there are no outstanding advantages to recommend the use of this system.

Fig. 1 shows twelve machines driven by belting directly from pulleys on a lineshaft, which is in turn driven by a single electric motor. In place of this motor a steam or internal-combustion engine can be used. In this layout the motor must have sufficient capacity to take care of the largest possible load that can be put on the shaft. This load would be that of all twelve machines starting at once, plus the load necessary to overcome the friction of the system, plus the power lost in the belts.

In operation, even with all twelve machines taking power at once, the load would be much less than the capacity of the motor, for the power required to keep the machines operating is much less than that necessary to overcome their inertia and bring them up to speed when

starting. The motor or engine necessary to operate the system shown in Fig. 1, hence, is large and costly. Should any of the twelve machines run at low speed, it may also be necessary to have the motor operate at relatively low speed, which, in the case of an electric motor, means added cost and low power factor. Also the shafting and hangers must be stronger and hence more expensive to install and maintain than would be the case if the system were designed to carry less load.

Fig. 2 shows an alternative system to carry out the same drive as in Fig. 1. The interposition of the four countershafts permits the use of a higher-speed motor, which costs less than that needed in Fig. 1, and is more economical to operate; and also lessens the amount of heavy shafting and hangers needed, thus making a further saving.

A greater saving, both in first cost and in operating cost, can be made by adopting a scheme similar to that shown in Fig. 3. Here the machines are grouped according to their speed and load characteristics. Each group is driven by a separate motor which is the lowest-horsepower, highest-speed motor that can be selected for the purpose. The aggregate horsepower and cost of these motors will be less than that of the single motor shown in Figs. 1 and 2. Also, these motors will run at much nearer their rated capacity and hence with higher efficiency. Shutdowns for repairs or maintenance are much less costly with this group-drive system than with the single-motor system, for it is seldom that more than one of the groups will be out of action at any given time.

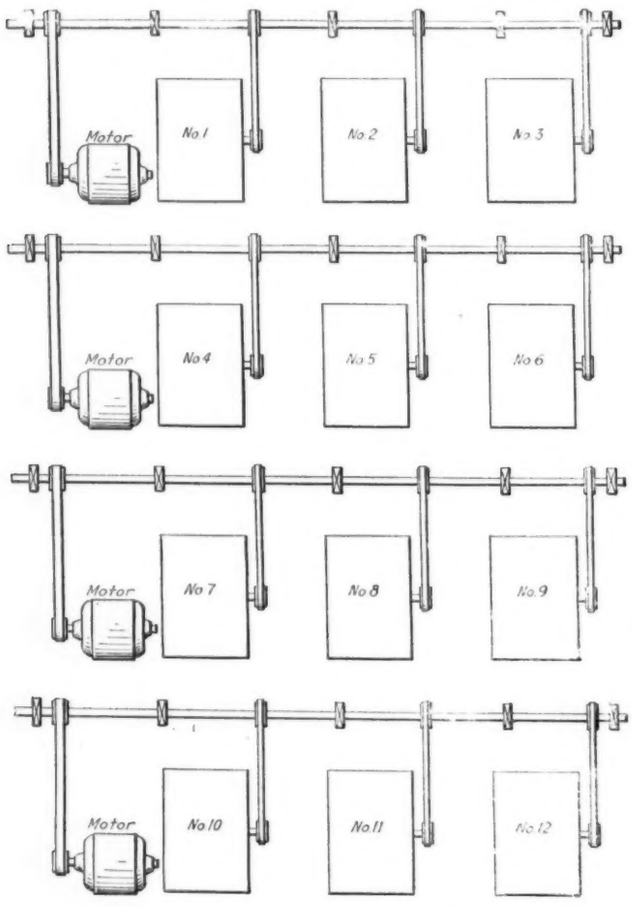


Fig. 3—Group drive applied to twelve machines shown in Fig. 1. Note the more compact space requirements

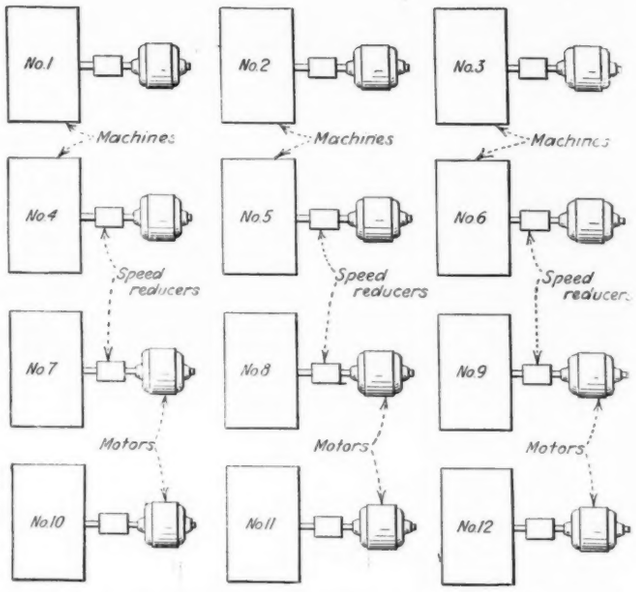


Fig. 4—Individual drive applied to machines shown in Fig. 3, by means of motors and speed reducers

Individual drive, for the same twelve machines as are shown in the other figures, is indicated in Fig. 4. Here each machine has a separate motor, driving the machine through a speed reducer or some other form of reduction. This method is not always the cheapest to install, although it may be. Sometimes the aggregate cost of the small, cheap, high-speed motors plus the cost of the speed-reduction devices, will be greater than the cost of motors and shafting of the type shown in Fig. 3. From an operating point of view, however, it is the cheapest. The motors can be used most efficiently and the load factor for the group is high. Shutdowns mean the stopping of but one machine. Repairs involve only relatively cheap parts.

In addition, the layout shown in Fig. 4 finds favor in many cases because of its extreme flexibility. Any single machine can be removed, changed or substituted for without affecting the economy or continuity of operation of the others. This factor alone causes many modern shops to use the individual drive system. In automotive shops, for instance, where the frequent changes in design of product cause frequent changes in equipment, the individual drive system has many advantages.

How to Choose a System

There is only one way in which a mechanical power transmission system for a shop can be properly selected. A detailed study of the machinery installed in the shop, its power requirements and speed of operation must be made. Also the most favorable operating schedule for the various machines and processes must be determined. With these facts in hand it becomes possible to select the equipment that will give the lowest mechanical power cost in the finished product. This cost is likely to be a compromise between various factors, for the system requiring the least energy may have a higher first cost or maintenance charge that will offset this. But if the end desired is always kept in view—low cost of power in the finished product—it is safe to say that the application and transmission of mechanical power will be carried out in the most economical manner available.

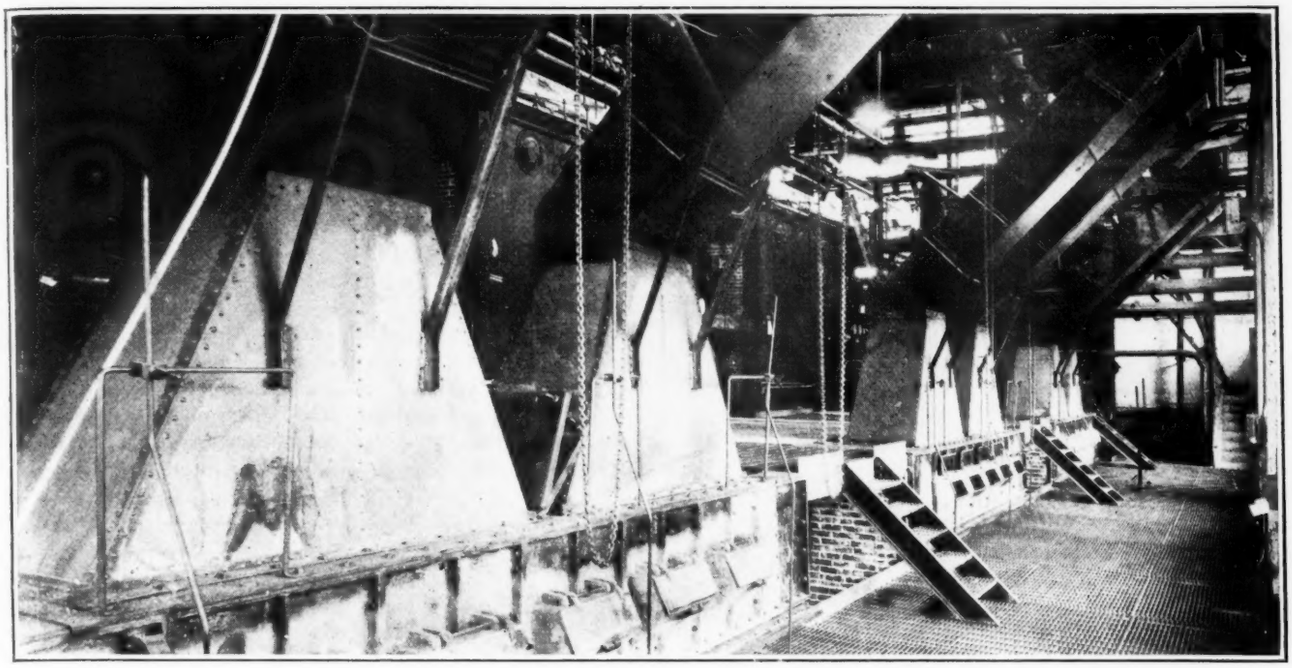


Fig. 1—Boilers equipped to burn hog fuel on Beecher step grates

HOG FUEL *and* WASTE HEAT GENERATE Paper Mill Steam

These sources of heat with oil firing as a stand-by are used by the Longview Fibre Company. Hog fuel is burned on inclined grates and all boilers are equipped with oil burners

FOR some time plans have been under way to make Longview one of the great industrial centers of the State of Washington. The town is favorably situated. Raw materials are available for a great variety of industries. Water power is to be had in abundance from near-by transmission lines to supplement power generated from waste fuel from lumber mills already established. One of the first enterprises of this development is the plant of the Longview Fibre Company, which makes sulphate kraft pulp and board at the rate of 120 tons a day. Situated adjacent to the enormous development of the Long Bell Lumber Company, the raw material, consisting of waste wood, principally Douglas fir, is readily available; and from the same source is to be had hog fuel for generating steam.

Steam required for process is in excess of the power steam; the demand, particularly for the digesters, is irregular; and for much of the steam the pressures required are such as to prohibit combined operation. For example, steam for cooking is reduced from a boiler pressure of 190 lb. to 140 lb.; steam at full boiler pressure is used to evaporate the black liquor for the recovery process; and steam for drying is bled at 20 lb. pressure from the main turbine generating unit, which is rated at 2,500 kw. and is operated condensing. With a connected electrical load of 7,500 kw. the average load ranges from 3,500 to 4,000 kw. Current for power up to 2,000 kw. is purchased at a low rate from the Long Bell Lumber Company, and the remainder of the load is cared for by the bleeder turbine.

Steam for all purposes is generated at 190 lb. pressure by six Stirling boilers—three equipped for the direct firing of hog fuel with the reserve provision of back-shot oil firing at the rear of the setting, and three being waste heat boilers with oil burners in reserve. The latter utilize all heat that is available from the burning in recovery furnaces of the waste sulphate liquors, a system doing away with any fumes that might come from a mill of this type, and at the same time generating a considerable portion of the total steam needed. The six boilers are

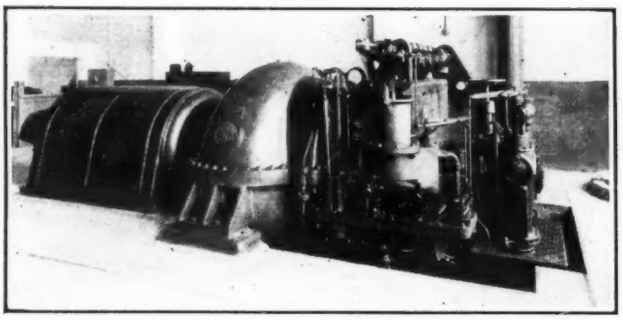


Fig. 2—Bleeder turbine generating unit rated at 2,500 kilowatts

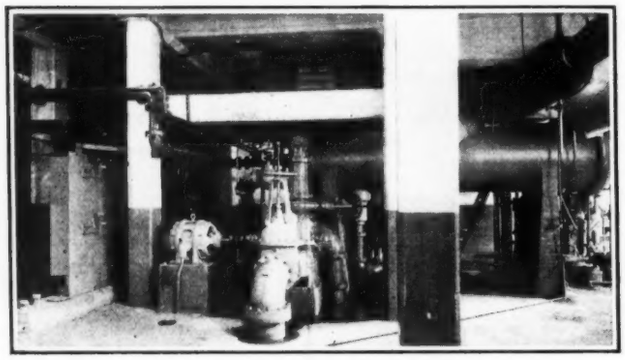


Fig. 3—Condenser and auxiliaries serving turbine generating unit

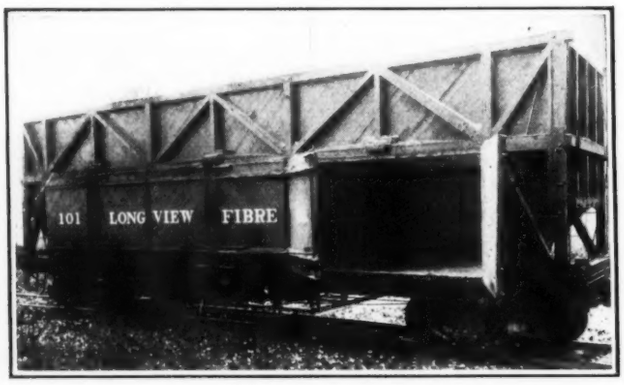


Fig. 4—Special car made to transport the hog fuel

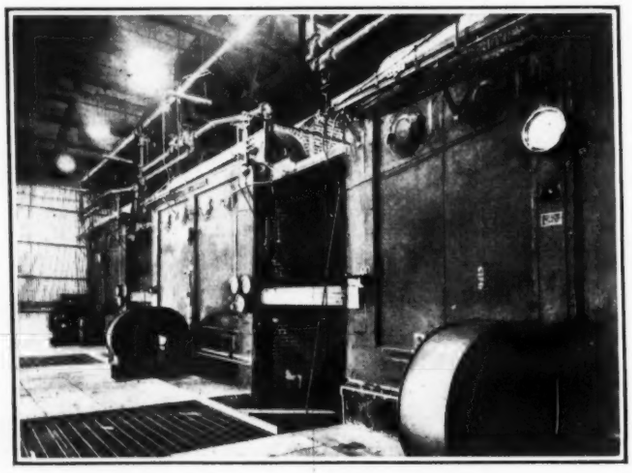


Fig. 5—Direct-fired boilers and fans to circulate secondary air

connected by a ring-header, with sectionalizing valves ordinarily left open, so that all the steam possible will be generated by the waste-heat boilers and the rest be drawn as needed from the boilers fired with hog fuel. Fig. 6 indicates the arrangement.

In the direct-fired boilers, superheaters that will raise the temperature of the steam 150 deg. F. at 150 per cent rating have been provided, but were omitted from the waste-heat boilers. The waste gases enter the latter at a temperature of 2,000 to 2,300 deg. F. and pass to the breeching at a temperature approximating 500 deg.

As indicated in Fig. 6, the boilers are set singly, the direct-fired boilers each having 8,343 sq.ft. of steam making surface, as compared to 5,700 sq.ft. for each of the waste-heat boilers. Construction of the setting is of the hollow-wall suspended type. The bottom of the furnace is made up of four inches of concrete followed by hollow tile. Air from the side walls is circulated through

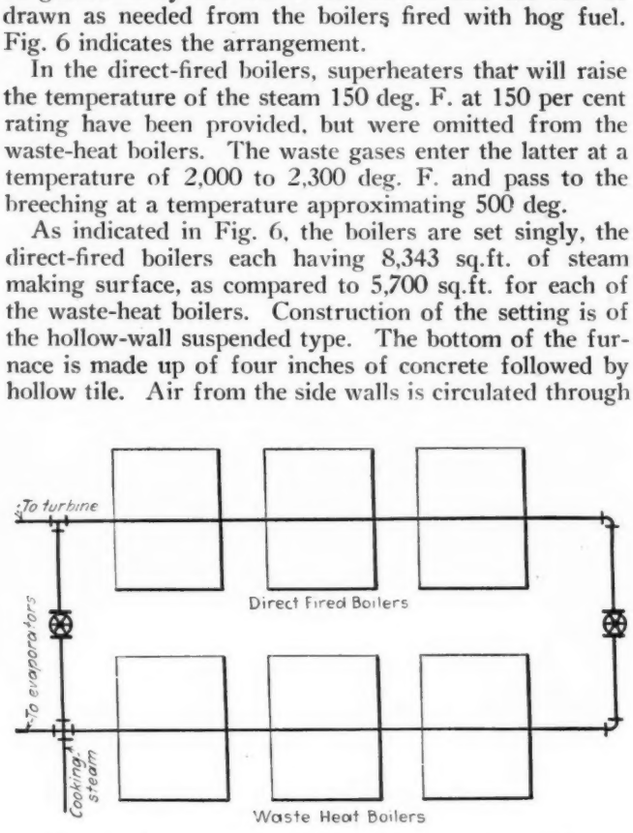


Fig. 6—Loop header system serving the six boilers

the hollow walls by motor-driven fans and introduced through ports in the bridge wall, front and rear, as the secondary preheated air supply to complete combustion. Primary undergrate air is introduced by natural draft from a concrete stack 300 ft. high and 13 ft. in diameter at the top.

The three direct-fired boilers are equipped with Beecher step grates, 17 ft. wide and 14 ft. long. The combustion arch extends beyond the grate by five feet and is provided with a drop nose to deflect the gases of combustion downward so that they will mix more thoroughly with the secondary air. A fuel bed eight to ten inches thick is carried, but the thickness may be varied by an adjustable cast-iron fuel gate at the top of the grate. Water pans under the grates collect the riddlings, which are drained off intermittently into the sluicing system. The boilers are ordinarily operated at from 175 to 200 per cent of rating.

The fuel-handling system is featured by specially constructed hog fuel cars that will carry 19 units of 200 cu.ft. from the storage in the Long Bell fuel house, 1¼ miles distant. These cars are 9 ft. 6 in. wide, 10 ft. high and 40 ft. long. As indicated in Fig. 6, they are divided into three compartments, each having two swinging doors, hinged vertically, on either side. Undercutting the fuel causes it to avalanche on either side into a track hopper at the power plant. From the hopper an inclined chain conveyor carries the fuel to a horizontal flight conveyor running along the boiler fronts at an elevation suitable to discharge the fuel through chutes into the furnaces. Any surplus fuel is carried over the

end of the horizontal conveyor and is discharged onto an inclined conveyor to be recirculated.

As much of the condensation from the process steam does not get back to the boilers, the percentage of makeup is large. The water is drawn from the Columbia River by turbine-driven pumps and is passed through a hot-process treating plant before delivery is made into the feed-water heater. Through a loop system the water is sent to the boilers under the control of feed-water regulators.

Fig. 2 shows the generating unit, consisting of a 2,500-kw. bleeder type turbine driving a 440-volt three-phase 60-cycle generator at 3,600 r.p.m. The unit is served by a surface condenser containing 2,500 sq.ft. of surface and equipped with the usual auxiliaries such as dual steam-jet air pumps and motor-driven circulating and condensate pumps. Cooling water comes from the river and, after being passed through the condenser, is introduced into the mill supply. To supplement the output of this unit, service from the plant of the Long Bell Lumber Company, brought in over a 13,200-volt line, is stepped down to 440 volts for use in the mill.

The design and installation of the plant is to be credited to the Seattle office of C. C. Moore & Company, co-operating with C. R. Seaborne, designing engineer for the Longview Fibre Company.

ANSWERS to "What Do You Know"

The questions are on page 718

Ans. 1—The forces exerted by the two teams are equal but opposite in direction. The reason one team outpulls the other is that the force it exerts is sufficient to overcome the resistance of the second team, while its own resistance is so great that the second team's force cannot overcome it.

Ans. 2—The sections of a steam radiator are joined together at the bottom only, while those in a hot-water radiator are connected at both top and bottom. Hot-water radiation may be used for steam, but steam radiation cannot be used satisfactorily for hot water, because air would become trapped in the top of each section, preventing the water from filling them.

Ans. 3—No. It has been proved that, when correctly designed, the furnace need not be so large as has been assumed.

Ans. 4—The grates should be at least 42 in. below the boiler, and a diffusion arch should be erected back of the bridge wall.

Ans. 5—In the English town-gas industry "therm" means 1,000 B.t.u., but in this country gas is sold by the cubic foot and not heat content, so the term is seldom used here.

Ans. 6—The meeting will be at Penn. State College, State College, Pa., from June 14 to 16.

Ans. 7—Based on the energy used by the apparatus itself, the dry vacuum pump is the more efficient, but since this pump must be supplied with power generated by an engine or turbine of low thermal efficiency, the steam air jet works out as having a better net efficiency.

Ans. 8—No. At high speeds the pump plunger may move so fast on the suction stroke as to form a vacuum and steam bind.

Ans. 9—If the impeller is turning at its regular speed, it will throw the water out against the casing and trap air at the center, so that the suction connections cannot be filled with water, and the pump will not pick up its load.

Ans. 10—One should relieve at the maximum allowable working pressure, say 205 lb., and the second within a range of 3 per cent above this, or at 211 lb.

Data on High-Pressure Boiler Installations

WITH the article "Operating Experience with High-Pressure and High-Temperature Steam," by G. A. Orrok, appearing in the Feb. 21 issue, was published a table of data on high-pressure boiler installations. The table gave information on the important features of both American and foreign plants using steam pressures over 500 lb. per sq.in. absolute.

Data have been received on five other plants, one of them in Pekin, Ill., and the others in Europe. Additional information on the plants containing Benson boilers has been made available by the American representative of the Siemens Schuckert Company, who has also corrected some of the data previously published on these installations. These changes are given in the table.

DATA ON HIGH-PRESSURE BOILER INSTALLATIONS

Location		Boiler			Superheater		Reheater		Econ-omizer	Prime Mover			
Plant	Place	Type	Make	Abs. Pressure Lb. per Sq.In.	Surface, Sq.Ft.	Surface, Sq.Ft.	Total Temp. Deg. F.	Surface, Sq.Ft.	Total Temp. Deg. F.	Surface, Sq.Ft.	Make	K.W.	Speed, R.P.M.	Barrels
Pekin	Illinois			615	....	....	725	....	725	....	G. E.	52,500	....	2
Arnam Paper Mills	Czecho-Slovakia			725	....	....	725	....	....	....	Escher-Wyss	1,139	7,500	2
Cottland	Sweden			800	4,840	....	752	....	752	....	Ljungstrum	5,800	....	2
Magdeburg	Germany			1,415	....	....	752	....	752	....	De Laval	500	15,000	1
Mulhouse	France	Rotating tube	Atmos	1,415	....	....	752	....	....	....	Soc. Alsacienne	700	10,500	1
English Elec. Co	Rugby	Coil	Benson	3,200	1,300	300	862	....	....	....	E. E.	360	25,000	1
Siemensstadt	Berlin	Bent tube	Benson*	3,200	1,863	466	752	....	....	3,280	Escher-Wyss	1,000	10,000	1
Gartemfeld	Berlin	Bent tube	Benson*	3,200	2,180	2,966	790	3,080	824	....	Escher-Wyss	3,200	6,000	2

*Siemens Schuckert.

Why Use a Lathe

on Commutators and Slip Rings

When a Hand Stone Will Do the Trick?

By H. E. Stafford

Electrical Engineer,
Provincial Paper Mills, Limited

NO PART of a direct-current generator or a motor requires more care and attention than the commutator. Owing to its construction, a commutator is sensitive to moisture, high temperature and dirt, and it is therefore necessary that it be kept clean at all times. With proper attention a commutator will last almost indefinitely.

Arcing between the commutator and brushes is usually the first symptom that something is wrong with the machine. It must not be taken for granted, however, that the trouble is always in the commutator, since an open circuit or a short circuit in an armature coil will cause arcing. If the machine is operated for any length of time under either of these conditions, it will cause serious commutator trouble. With a short circuit in an armature coil a burned out coil is generally the result.

Arcing between the commutator and brushes, in addition to the two causes enumerated, which are winding faults, may be due to the commutator's surface being rough or pitted. This defect may be caused by the bolts holding the clamping rings being loose; overloads; brushes out of line; improper brush tension; brushes off neutral position; brushes too abrasive; brushes jammed in the holders; high mica; high or low bars, thus causing the brushes to chatter and make poor contact; too great a current density per square inch of brush contact; brushes too wide or too narrow, thus spanning too many or too few bars; commutator oval shaped or otherwise out of round; copper segments too soft or mica too hard, where the commutator is not undercut; or a weak magnetic field.

Truing Up a Commutator

The first care in overcoming commutator trouble is, of course, to remove the cause. After this is done, the commutator should be trued up, the mica undercut in most cases, and any holes in the commutator, where the mica has been burned deep, filled with cement.

The truing-up process may be accomplished in a variety of ways. The oldest method, which is still used to a considerable extent, is to employ a cutting tool, the armature being revolved in a lathe. For machines that are too cumbersome to be placed in a lathe, the lathe head and cutting tool are mounted on the machine and the armature turned slowly by means of a small motor or other motive power.

Fig. 1—Method of applying a hand stone to a large commutator

Another method, which does not require the removal of the armature, is to make use of a grinding wheel. There are various ways of using and mounting the wheel. The wheel spindle may be mounted in a lathe head fastened to one of the rocker arms and driven by a small portable motor through a flexible shaft. Another way is to use a portable motor having the wheel mounted on the end of the motor shaft, the whole being mounted on a lathe head. In other cases the grinder is mounted on the machine and is driven by a separate belt from a motor, as in Fig. 4. Grinders have been developed that are driven by a friction pulley resting on the commutator. The grinding wheel and the commutator revolve in the same direction, thus the peripheral speed of one is added to that of the other. For satisfactory grinding a cutting speed of 7,000 to 8,000 ft. per min. should be secured. In other words, the combined peripheral speed of the

grinding wheel and commutator should be 7,000 to 8,000 ft. per minute.

Where either of these methods of truing a commutator is employed, the machine must be taken out of service, which means a shutdown and loss of production. It was primarily to overcome this situation that the use of commutator stones was adopted, and these have to a large degree, replaced the use of lathe tools and cutting wheels except where heavy cuts are to be made. The plant with which the writer is connected has had two commutators lathe-turned in four years, these having been replaced by spares over a week-end. All other truing has been done with hand stones. There are forty direct-current machines of all types and sizes in use at this plant.

Important features of commutator stones and grinding wheels is that they do not foul the copper; they cut faster than a turning tool; they cut the edges of every bar clean and do not drag the copper into the mica or across the slots. They are made in all sizes and shapes and have several degrees of abrasive quality.

Care Required When Using a Stone

Care must be used in operating a commutator stone, as a stone in the hands of a green operator may result in a ruined commutator. In practically all cases, the stone may be placed directly on a set of brush-holders toward which the commutator is turning, as shown in Fig. 1.

If the commutator is round and there are only ridges to be removed, direct pressure may be applied to the stone until the ridges disappear. The stone should preferably be less in length than the face of the commutator, but should be as wide as will conveniently fit between adjacent sets of brushes. If the stone is moved slowly across the face of the commutator, it will facilitate the speed of cutting and it does not allow the formation of ridges. If the commutator has burned spots on its surface, but is otherwise true, the same operation applies.

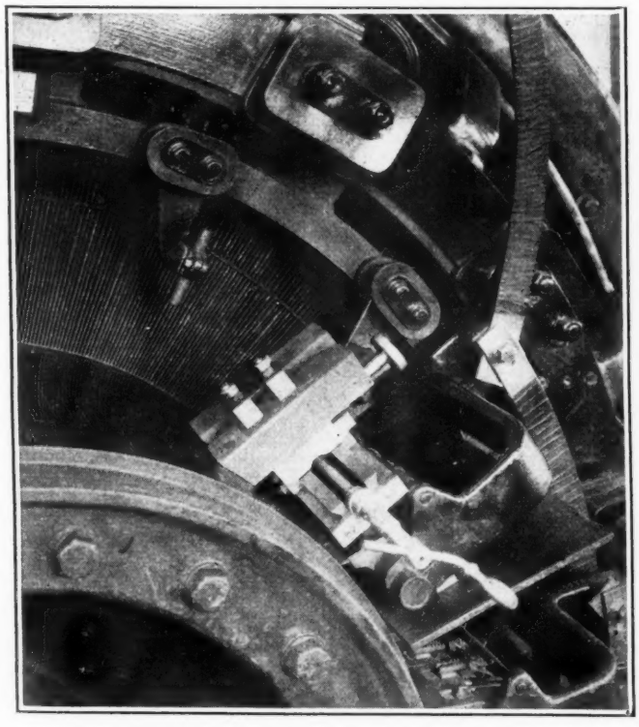


Fig. 2—Commutator being turned with stones mounted on an adjustable rest

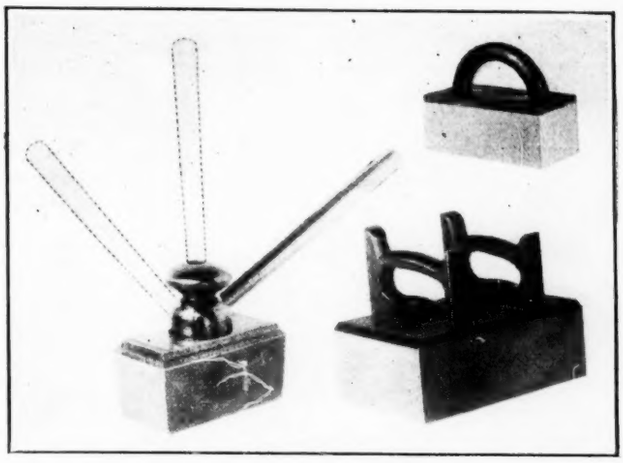


Fig. 3—Hand stone of different shapes and sizes

If, however, the commutator is out of round, the operation of the stone is different. In this case, if constant pressure were applied, it might aggravate the trouble. The operation in a case of this kind is to apply enough pressure so that the stone will just touch the commutator. The high spots will then be wiped off as the commutator revolves toward the stone, and experience alone will show the amount of pressure to apply. The same operation applies to high bars.

Advantages of a Stone

In plants having large machines such as rotary converters and motor-generator sets, the stones may be mounted in a stationary rest, or holder, which is fastened either to the frame or to one of the brush arms. The pressure of the stone is adjusted by a micrometer screw and the stone is moved across the commutator by means of a handwheel. Fig. 5 shows a grinding tool, while Fig. 2 shows one mounted on a brush arm. A tool of this kind may be adjusted to various size machines.

Before applying the stone, the commutator should be clean. If grease and oil are present, wipe or sandpaper the commutator before using the stone. If the commutator is dirty, the surface of the stone may be clogged with copper, which will interfere with the cutting. The stone should be held firmly on the commutator and not allowed to rock. In this way an arc is formed in the stone, which conforms to the shape of the commutator and facilitates obtaining a true surface on the commutator.

The advantages of a commutator stone, either hand or rest operated, over a cutting tool may be summed up as follows:

When using a tool, the commutator must be turned slowly, and if there is any spring or play in the mounting of the tool, there is a tendency to gouge the edges of the bars. Again, if any of the bars are at all loose, the tool will tend to push them in toward the shaft, and when the machine is put back into service, the centrifugal force will raise the bar higher than the others, causing the brushes to chatter and break. If the commutator is undercut, the tool will form burrs along the edges of the bars, in some cases turning these burrs into the slots, and if they are not removed they will cause a short

Electrical Applications

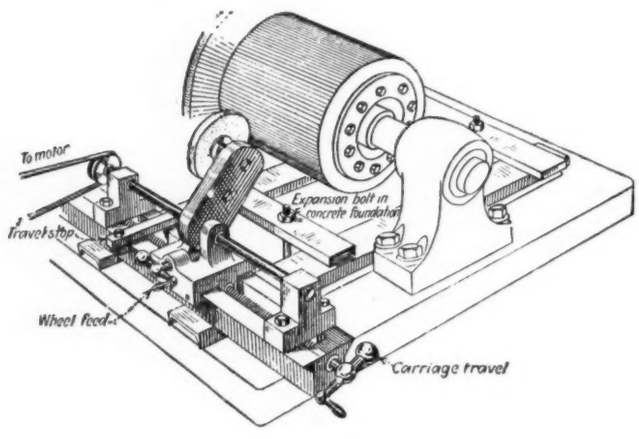


Fig. 4—Grinding wheel, belted to a motor, mounted to true up a commutator

circuit. Then again, the generator or motor, as the case may be, must be taken out of service, with the resulting loss of time and production if no spares are available.

With the use of a hand stone these disadvantages are avoided and in most cases a better job is obtained than with a tool.

Treatment of Slip Rings

The main trouble encountered with slip rings of synchronous motors, rotary converters, alternators and wound-rotor induction motors is that they become grooved by brush wear and flat in spots. The latter is caused from accidentally starting with a heavy current

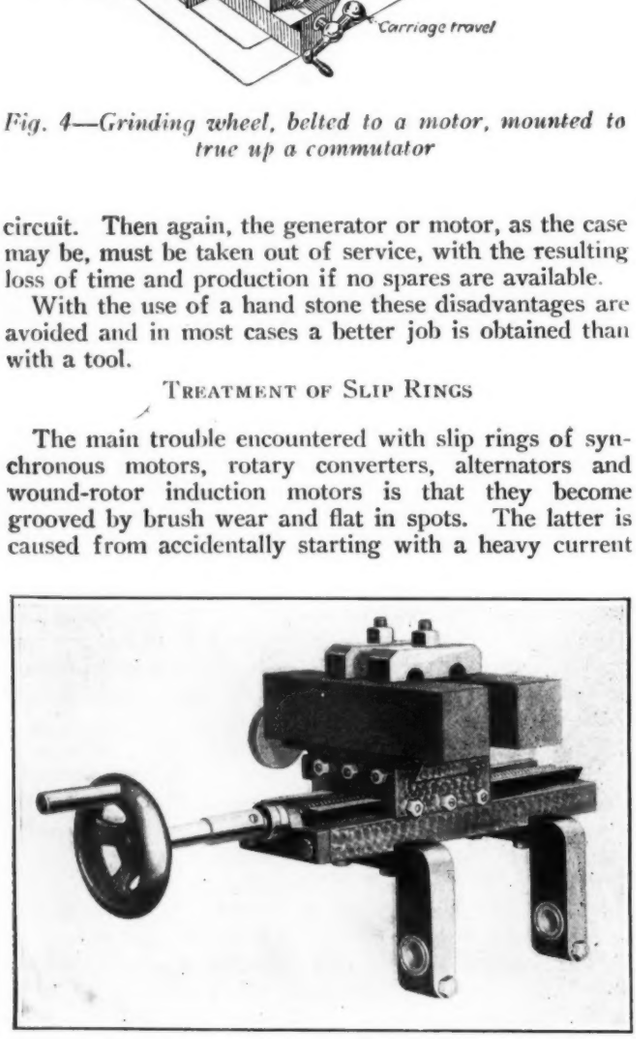


Fig. 5—Adjustable rest for commutator stones

flowing in the fields. Wear of slip rings on alternators and synchronous motors is retarded by changing the exciter leads periodically; that is, changing the direction of the current through the field coils. Slip rings are trued with a stone in much the same manner as are commutators. To remove flat spots it is necessary that the stone be held in a rest.

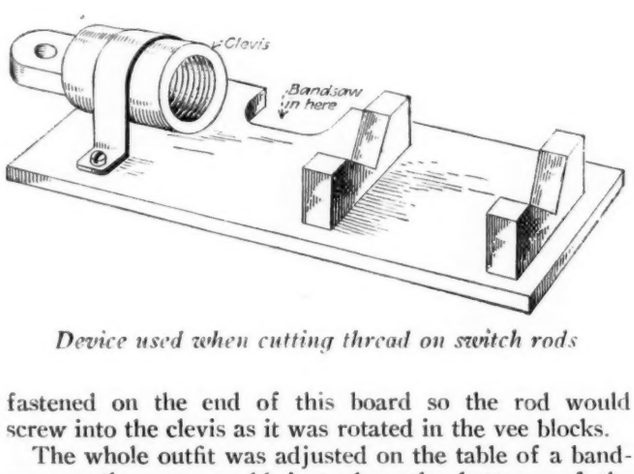
Photographs in this article were supplied by the Ideal Commutator Dresser Company and by The Martindale Electric Company.

An Easy Solution of a Special Threading Problem

By N. L. Rea
Construction Engineer, General Electric Company

MANY high-tension oil circuit breakers and disconnecting switches have operating rods made from treated hardwood. These rods are threaded for easy adjustment of the switches. Sometimes, owing to variations in cell dimensions, location of anchor bolts or other local conditions, the rods are too long. This makes it necessary to cut additional threads on the rods, which is a mean job even with the best equipment. It is almost impossible to get a good job with a lathe, as the treated wood is brittle and the thread tears out badly.

One of our construction men recently devised a scheme that gives good results quickly and at low cost, and the equipment is almost always available. Two wooden vee blocks were fastened to a piece of board, as in the figure, so that the switch rod could be held in them and turned. A clevis borrowed from the switch was



Device used when cutting thread on switch rods

fastened on the end of this board so the rod would screw into the clevis as it was rotated in the vee blocks.

The whole outfit was adjusted on the table of a bandsaw so the saw would just clear the bottoms of the threads, and was firmly clamped to the table. The saw was then started and the rod screwed forward into the clevis. This gave a spiral cut in the rod of the correct pitch and nearly of the right depth, and long enough to suit conditions. It was an easy job to finish the thread with a three-cornered and knife file, using the clevis as a gage. The thread made this way was as good as, if not better than, the factory-cut thread.

Heat Applied to Clear Frozen Conduit Wires

By M. J. Adams
Switchboard Engineer, Westinghouse Electric & Manufacturing Company

ALMOST everyone who is connected with power-house construction and maintenance has encountered the problem of trying to pull old wiring out of conduit. Invariably, these wires are stuck firmly in the pipe and sometimes resist all efforts to move them. This is particularly annoying when a hurried change is being made during off-peak loads and when the time for doing the work is limited.

This problem recently confronted the construction superintendent of a large public utility corporation. His

men were ordered to make a certain change in an automatic substation which could be shut down for a short period between the morning and evening peaks only. It was necessary to pull an additional wire into a conduit, which came within one wire of its capacity. It was therefore necessary to disconnect all these wires and pull them out and then pull in a new group with the additional wire included.

However, the workmen were unsuccessful in pulling out the wires. When the superintendent was called, the wires had all been broken off close to the conduit at both ends in attempts made to pull the group with block and tackle.

The station was due to go on the line in two hours, and the wires that were broken off in the conduit were vitally concerned in this. It was certain that they could not be pulled out unless they were first broken loose in the conduit. Upon arriving at the station, the superintendent ordered carbon tetra chloride forced into the conduit and then allowed it to stand for a time, but it made no appreciable progress toward freeing the wires.

Next, a bank of street-car grid resistance was secured and connected from the 600-volt source to one of the wires in the group. A piece of wire identical with those in the conduit was connected in the external circuit between the resistance and one of the wires and the other end of the group was grounded. The current in the circuit was increased until the insulation on the piece of test wire in the external circuit was charred and began to strip off. The circuit was then disconnected and the entire wire group was pulled out of the conduit without difficulty. A new group with the additional wire included was immediately pulled in and connected up, and the station was ready for service at the required time.

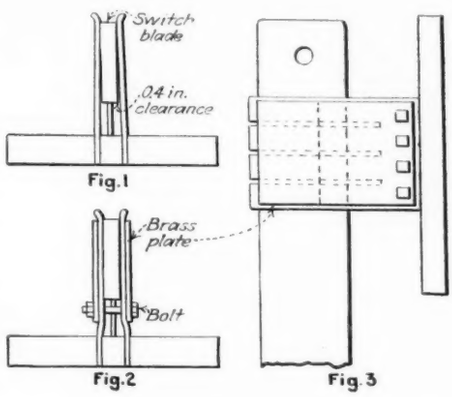
In this case the stripping of one wire freed the entire group, but in some cases it might be necessary to char the insulation on two or possibly more wires before the group could be released. In any case it provides a quick and sure escape from an exasperating situation.

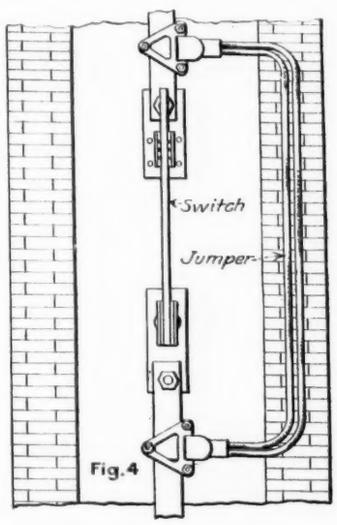
A check showed that the clips were making contact with the blades as in Fig. 1. To obtain sufficient carrying capacity, contact had to be made across the entire width of the switch blade. At the back of the blade, when closed, there was an average of 0.04 in. clearance between the blade and the clips. To improve the contact I pulled the clips against the blade by four bolts acting on brass plates outside the clips, as in Figs. 2 and 3. The first brass plates used extended only about halfway across the blades, but it was found easy to cause the clips to spring away from the front edge of the blade. Since the clips were equipped as shown in Figs. 2 and 3, the heating has not been excessive, even when operating the switches at their rated load of 1,200 amperes.

Some time ago I had to change the clip on a disconnect switch in a 2,300-volt busbar connection, without making the line dead. The plant was so heavily loaded that this section of it could not be shut down. The switch was mounted in a brick cell inclosure about twelve inches wide.

Before work on the circuit was attempted, the cell was lined with rubber matting. Also, a jumper was made from two 500,000-circ.mil cables. Lugs were soldered on these cables so that they could be clamped to the busbar as shown in Fig. 4. The connection shunted the switch and made it possible to make the repair while the circuit was alive and carrying full load.

Of course heavy rubber gloves were worn while doing the work, and all the other precautions taken to prevent getting a shock from the 2,300 volts. These jumpers are now maintained as a part of the regular repair equipment in the electrical department of the plant.





Figs. 1 to 3—Switch clips before and after adjusting. Fig. 4—Jumper installed before removing the switch

Making Repairs on Disconnect Switches

By Ray F. Good

WE HAD a number of disconnect switches that gave trouble from overheating. At first it was thought the difficulty was due to dust, of which there is considerable around this plant. After the switches had been carefully cleaned, the heating continued and then the trouble was placed to improper lining up of the switch blades with the clips. Lining up the switch blades with the clips reduced the heating some, but did not entirely cure the trouble. As it was known that the load would be increased on the lines, the switches had to make better contact if they were to carry the load without overheating.

Changing Voltage of Converter

THE voltage of a rotary converter cannot be varied by simply varying the field strength as in the ordinary direct-current generator. It is necessary to provide some means for changing the applied alternating-current voltage, which can be accomplished in a number of ways, such as bringing out a number of taps from the transformers, shunt-wound converters with induction regulators, compound-wound converters with reaction coils, regulating-pole converters and series-booster converters.

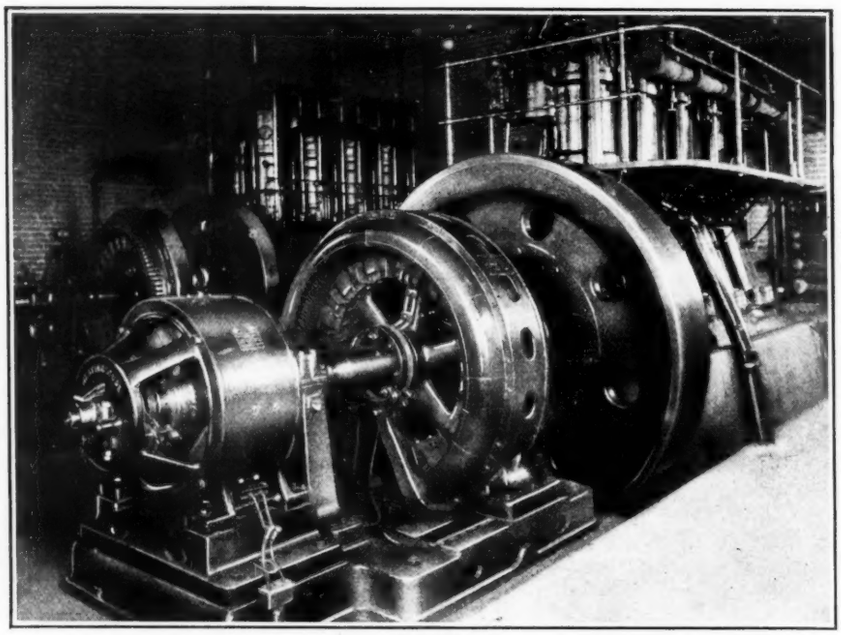


Fig. 1—The Kamsack plant, showing the first Diesel and the old gas engine

Saving Money in a Small Power Plant

A story of the Development of a Municipal Power Plant—Interesting home-made apparatus—Savings in buying fuel and lubricating oils

By James M. Bloomfield

Superintendent, Municipal Light and Power Plant, Kamsack, Saskatchewan, Canada

POWER is a commonplace servant and its possibilities uninspiring as compared with the opening of new markets for consumers of manufactured products, but the finding of a power-wasted dollar in a power plant is just as profitable a job as is the creation of a more spectacular trade dollar. The crux of this article is, therefore, not the matter of making economies so evident at first sight and actually made by reorganization of a plant, but the subsequent smaller economies that have done so much to raise the total.

The majority in the smaller towns are usually satisfied if the local electric light plant gives its consumers a fairly dependable service, provided the cost of operation does not show marked increase from year to year without being accompanied by a corresponding reduction in the rates at which the energy is sold.

The municipal plant of Kamsack, Saskatchewan, Canada, when installed in 1914, was equipped with a producer-gas engine. If my memory serves me, the plant operated exclusively on producer gas from the date of installation to the fall of 1919. Meanwhile the price of anthracite had risen from in the neighborhood of $10 a ton to $19.40 a ton delivered to the power house.

During the spring of 1920 a 200-hp. four-stroke-cycle air-injection Diesel engine of a reputable make was installed. This engine, Fig. 1, was purchased second-hand and at a price of only $1,000 less than the price of the same engine today, although it was nine years old at the time of purchase.

This Diesel engine, prior to my taking charge three years later, had consumed a total of about 10,000 imperial gallons of fuel oil, and apparently it was kept more as a show piece and put into operation only when the gas engine failed.

Many of us know to our sorrow that the financial position of small towns as a rule is generally somewhat embarrassing, and while I could see immediate economies, to carry them out was entirely another matter.

Records during the fall of 1923 conclusively proved the fuel and lubricating economy of the Diesel engine. Even at the price we were then paying for oil (17½c. per gal.), the fuel cost was only one-half that of the gas engine, and furthermore, the lubricating oil consumption was only one-third that of the gas engine under the same operating conditions. A tentative suggestion was made to the town

council and later adopted, to put the saving thus effected into a reserve fund to provide for another oil engine.

With the help of our reserve fund a second Diesel engine of 250 hp. was purchased and installed in the fall of that year.

Among the numerous small economies effected during the two years, mention may be made of the following: The use of a heavier and hence a cheaper grade of fuel oil; reclamation of lubricating oil; the choice of a suitable

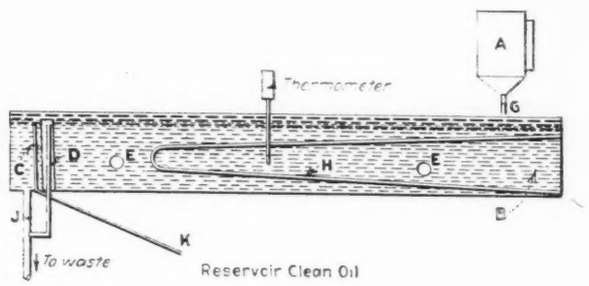


Fig. 2—Cross-section of the oil reclaimer

lubricating oil; checking lubricating oil wastes; recovery of oil and wiping rags formerly thrown away; an improved cooling water system and a new method of heating the building.

I have placed fuel oil first in the list, not that a very substantial saving was made on an annual consumption of over 50,000 imperial gallons, but more from the viewpoint of whether it would justify the extra trouble and worry in keeping the engines in tune together with the question of handling the oil.

Being Scotch and therefore cautious, I first made inquiries from several Diesel plants as to the grade of fuel oil being used and whether a lower gravity had been tried and, if so, with what success.

The replies to my query were disappointing, as all were using the same gravity, a distillate of 36-37 deg. Baumé, like ourselves; those who had tried the heavier oil were non-committal as to their success or otherwise, the general opinion being that trouble would arise during the winter months, when the oil would become so thick that it would be difficult to handle.

However, several sample barrels of fuel oil ranging from 21 to 25 deg. Baumé were obtained from different oil companies. From each a small quantity was sent away for analysis, while the remainder was used in the engines, particular attention being given to starting, speed regulation, blast pressure and fuel consumption.

Out of the samples analyzed, a grade was picked out showing the highest heat value, lowest ash, sediment and sulphur content. Comparison of the two grades are given in the table.

	Distillate	Heavy Oil
Price per gallon, cents	17.5	14
Gravity @ 60 deg. F., deg. Bé	38	22.9
Specific gravity	0.8333	0.9156
Flash point, deg. F.	215	225
Burning point, deg. F.	235	265
Viscosity at 122 deg. F., Saybolt furoil sec.	3	15
B.t.u. per lb.	19,365	19,062
B.t.u., per gal.	161,370	174,531
Sulphur, per cent	0.22	1.78
Ash, per cent	6	.01
Sediment	0	Trace
Water	0	Faint trace
Coke residue, per cent	.....	2.72
Ashphaltum	0	0

The engines have been operating on this heavy grade for about six months and so far with complete success and satisfaction. To overcome our rigorous winter difficulties in pumping the oil from the main storage tanks, which are placed above ground outside, all 2-in. pipe was replaced by 3-in. We find that a rotary-type motor-driven pump with the suction submerged, handles the oil successfully in the coldest weather.

The system of filtering lubricating oil used up to the time we discarded the gas engine, consisted of passing the dirty oil over a series of perforated trays, allowing it to settle and drawing off from the top. Besides being very inefficient and inconvenient, a considerable quantity of oil was lost as it was being carried from the engine to the filter, the path between these two points being clearly defined by the spilled oil.

Filtering Apparatus Adopted

The simple apparatus shown in Figs. 2 and 3 has given us a first-class system of filtration. Its efficiency is shown by the records of our annual lubricating oil consumption for 1925 and 1926, these being 5,305 and 5,170 b.hp.-hr. per gal., respectively.

The trough *B* is 9 ft. long, 14 in. wide and 10 in. deep, and is made of 20-gage galvanized iron. About 8 in. from one end two pipes *D* and *C*, 3 in. apart, rise from the bottom of the tank; the overflow pipe *D* is 8 in. high and the height of the filtered-oil pipe *C* is 8⅓ in. A larger pipe longer than *D* is slipped over *D* and is capped to prevent the film of oil from flowing down the waste pipe. The water, being below the oil, rises up along the larger pipe and escapes down *D*. A valve *J* is connected with an elbow and tee to the overflow pipe and is used as a drain when cleaning out the tank.

Two 500-watt 110-volt immersion heaters are inserted in the tank at *E* for use during the summer months, while a steam coil *H* is connected to the station low-pressure

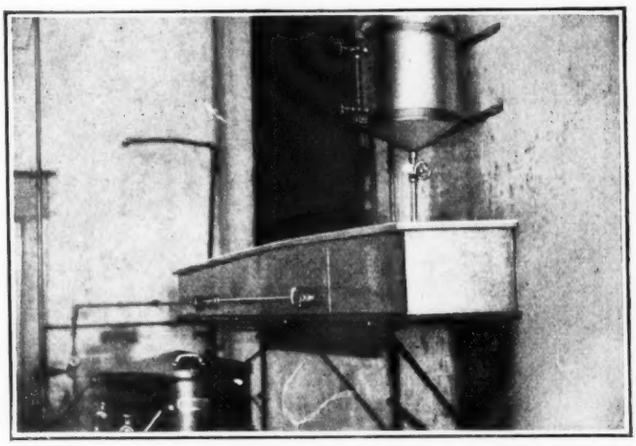


Fig. 3—A view of the reclaimer erected

steam-heating system for use during the winter months. Dirty oil from the crankpit is pumped into an overhead tank *A*, fitted with a strainer, gage glass and valve. The trough is filled with water up to the level of the overflow pipe *D* and kept at a temperature of 130 to 140 deg. F., by means of either the immersion heaters or steam coil.

Dirty oil from the overhead tank is allowed to flow on to the surface of the water at about 1½ to 2 gal. per hour.

A film of oil approximately one-eighth of an inch deep

moves slowly over the heated water and precipitates all solids, leaving the oil clean as it flows into the reservoir *K* ready for immediate use.

Filtered oil is used exclusively for all pistons, including those of the high- and low-stage air-compressor cylinders and crank and also on the wristpin bearings. The makeup oil is added to the ring-oiling main bearings, is allowed to overflow and to flow to the crankpits. The trough is cleaned about once a month, when about 20 to 30 lb. of sludge is removed.

The Most Expensive Oil Is Not Always the Cheapest

The question of a proper grade of lubricating oil is one of considerable importance, and my experience has been that not always the most expensive oil is the one most suitable. The oil we had been using up until the last six months was a well-known brand recommended by the engine maker and cost $1.20 per imperial gallon delivered. Analysis obtained of this oil was used as a basis of comparison for samples of other well-known makes of oils. Finally I got one whose analysis was practically identical with the original and at a price of only 72c. per gal. The analyses of the two grades were as follows:

	Original Oil	Present Oil
Cost per gal	$1.20	$0.72
Gravity @ 60 deg. F., deg. Bé	25.3	24.8
Specific gravity	0.9015	0.9034
Flash (closed) cup, deg. F.	406 F.	412 F.
Viscosity at 70 deg. F. (Redwood), sec.	998	1,021
Viscosity at 120 deg. (Redwood), sec.	57	58
Pour point, deg. F.	—16	—14
Color	Dark red	Dark red

We have been using this latter grade of oil with marked success, and at our annual overhaul all wearing parts

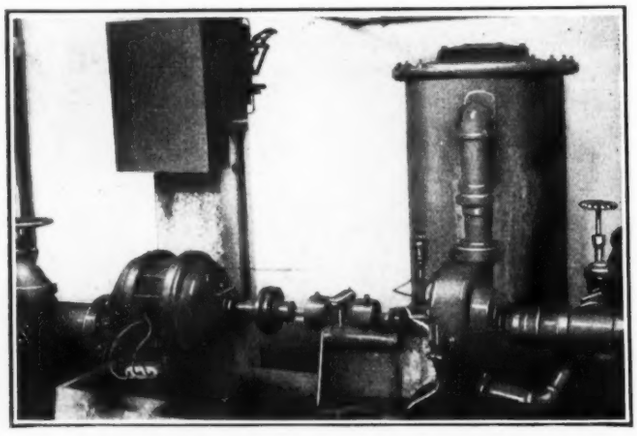


Fig. 4—The cooling-water pump and filter

were found in excellent condition and all piston rings were clean and free in their grooves.

To check slopping, the filtered lubricating oil from the tank is allowed to flow into a standard Bowser oil tank fitted with a pump. A connection is taken from the elbow by substituting a tee on the top of the pump; two valves are provided, so that oil can be pumped either into a container or to an elevated auxiliary tank in such a position as to give sufficient head to feed the engine oil boxes by gravity. Each oil box is equipped with a bib cock to regulate the supply. This plan relieves all necessity of carrying oil in cans up onto the engine platform.

To remove oil from wiping rags, an old family mangle with hardwood rollers was resurrected from somewhere and is now used for squeezing out all our oily wiping rags. By this means we are recovering about 30 per cent of our rags and from one to two gallons of oil per month, which is passed through the filter and is used again.

Before our second Diesel was installed, we had been

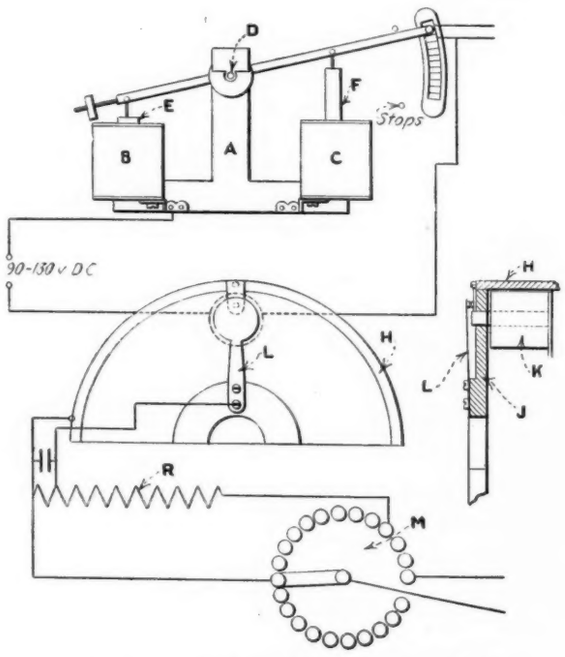


Fig. 5—A home-made voltage regulator

using the cooling water from our water-works department, situated in the same building, and letting it waste to the drains, the electric light department being charged at 20c. per 1,000 gal. The cooling water was not only costly, but also was a constant menace, more especially during the spring floods, when quantities of small leaves and twigs were constantly passing into the cylinder jackets. To obviate any danger of choked cooling system and, secondly, to charge the cost of pumping to ourselves, a pump and filters were installed, as shown in Fig. 4.

A discarded burnt-out 3-hp. motor was picked up for a song, rewound and put into good condition and coupled direct to a 100-g.p.m. centrifugal pump. The unit was mounted on a channel-iron base and arranged with the suction connected to the common well of the water-works department and with the delivery side of the pump piped into the top of a filter made from one of the numerous coal hoppers of our defunct gas producers. Near the bottom of this hopper was fitted a perforated tray on which four to five dozen loofah, or vegetable, sponges were placed. These sponges, when swelled with the water, practically filled the hopper.

The delivery pipe to the engine was taken from the hopper just below the perforated tray, while a drain was provided in the bottom for flushing out. Charging ourselves electrical energy at actual cost, a saving of $80 a month was effected; moreover, only a small accumulation of soft mud now forms in the cylinder jackets, which can be washed out easily.

The filtering sponges are taken out every three months.

thoroughly washed and put into service again. Once a year a complete new lot is put in, costing us $8.

Between the filter and engines a pressure gage suitably altered and arranged in conjunction with an alarm bell and bell-ringing transformer warns the operators in case the flow of cooling water ceases.

A problem we in Canada are faced with is the heating of buildings, owing to the severity of our winters. Knowing the bore, stroke and r.p.m. of the engine, one can readily ascertain the amount of air consumed per minute or per hour. This, divided into the cubical contents of the engine room, will give a rough approximation of the number of times the room is emptied and refilled with fresh air, which must eventually come from outside. This was noticeable the first winter we used the Diesel engine exclusively and more so after the installation of our second and larger unit. Figuring it roughly, the 200-hp. engine empties the engine room about once an hour, whereas the larger unit empties it nearly twice every hour. By installing suitable galvanized pipes to bring the cylinder air from outside the building, a noticeable saving has been made with our heating problem besides providing greater comfort for the operators.

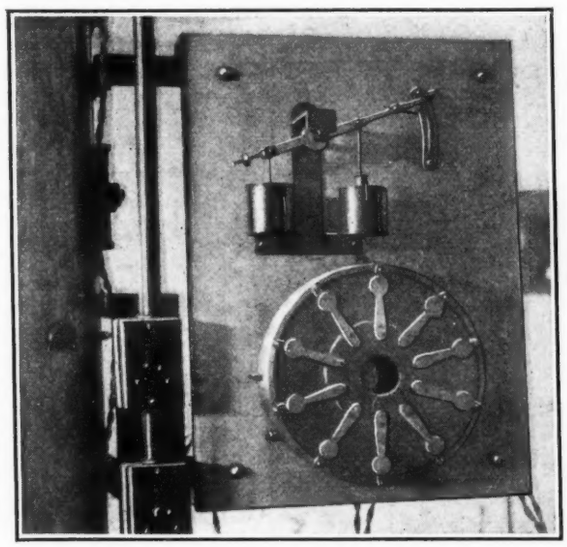


Fig. 6—The voltage regulator assembled

Those small plants equipped with a voltage regulator or perhaps where no sudden large demands are made upon their station generators, are fortunate. We, on the other hand, had some disappointments in handling a heavy fluctuating railway load.

The spray pressure problem was tackled first, as it appeared the simplest, so that the operators would be relieved from constantly keeping watch on the blast pressure.

A simple means of controlling the intake air to the low stage of the air compressor by the movement of the governor arm was experimented with until an apparatus was developed to function satisfactorily.

The question of voltage regulation, on the other hand, called for considerable ingenuity and some patience. While the home-made regulator, Figs. 5 and 6, we finally built might be in the nature of a joke to our electrical friends, it functions and does away entirely with hand regulation.

The main control A consists of a T-shaped piece of $\frac{1}{8}$-in. brass on which are mounted B, an alternating-current 110-volt potential coil, and C, a current coil connected in series with secondary of a 60 to 1 ratio current transformer.

An aluminum arm pivoted at D on jewelled bearings, is provided with two laminated cores E and F in the potential and current coils respectively.

At one end of the arm is an adjustable nut for balancing, while at the other end a small carbon pencil suitably mounted bears lightly and is free to move on a series of copper segments mounted on a piece of vulcanite. A light brush bears on the pivot spindle, providing a path for the current from the main frame through the arm and carbon pencil to the segments.

The relay apparatus is situated immediately below the main control and consists of a wrought-iron ring H, turned out of a piece of 8-in. pipe. A stepped fiber disk J is fitted into it, and on this are arranged ten magnets equally spaced in a circle. Of these only one K is shown in the diagram, Fig. 5. A separate resistance R is mounted on the back of the instrument and taps are taken off and connected to each of the ten fingers L, these being Ford coil vibrators, and the case forms a common return. This resistance is connected in parallel with a part of the shunt field rheostat of the exciter M as shown.

Condensers are provided where shown to prevent excessive arcing, but they could be improved considerably.

The working of the regulator is as follows: Assuming the generator to be operating at no load or very light load, the position of the main control arm will be as shown. As the load increases, the voltage drops slightly across the potential coil while the current increases across the current coil, thus pulling the arm down to some predetermined position. As the carbon pencil moves over each segment, it energizes each of the ten control magnets in rotation. Immediately each magnet is energized, it draws the finger L to it and short-circuits a part of the resistance in parallel with the exciter field rheostat, thereby raising the exciter voltage and the terminal voltage of the alternator. Similarly, the operation is reversed as the load decreases.

A double-throw switch is provided to connect the regulator to either exciter-field rheostat.

Oil-Engine Pistons

IF AN oil-engine piston is badly worn, new piston rings will serve to hold the compression, but they are only makeshifts. If a piston is so badly worn as to "slap," it is safe to assume that a new one is necessary.

If a piston ring sticks in the groove, the gum can be loossened by using a piece of spring brass. Copious supplies of kerosene will also serve to loosen the ring; lye water is equally serviceable. The groove and ring should be thoroughly cleaned before the ring is replaced on the piston. If the ring is new, frequently the edges are rough and sharp. All roughness should be removed by a smooth file. In replacing piston rings, they should be fitted to the cylinder with about 0.01-in. gap clearance between the parted ends.

Modern pistons are usually made with a taper at the top starting below the top rings. The clearance close to the top may be half an inch.

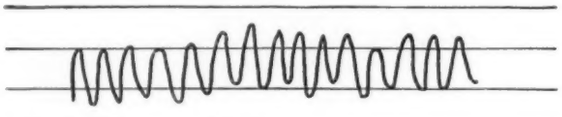
IDEAS FROM PRACTICAL MEN

For the exchange of practical information and ingenious expedients in operation and maintenance of plant and equipment

Another Use for the Steam-Engine Indicator

THE recording pressure chart from the discharge of a large exhauster showed a wide variation in pressure. The record was more of a ribbon than a line but it was impossible to distinguish any definite separation between the up and down movements.

In order to record the actual pulsations of the exhauster, to obtain the character and range, it was decided



Facsimile of indicator diagram

to use an indicator with a special spring for the range of pressure in the line. This pressure was about 3 lb. average, so that a 2- and a 4-lb. spring were used.

The demarcation was surprising, the motion of the pen being distinct and easily readable. By means of the proper scale, we were able to get the extent of the pulsations. We were not interested in the time of the pulsations, as this could be obtained from the speed of the exhauster. It would have been hard to time the paper speed. As it was, we simply put the indicator on the gas line and moved the paper by hand at the desired speed, obtaining a clear sharp diagram as illustrated that corresponded to the actual chart record.

Dayton, Ohio. C. W. STEVENS.

Handling Oil-Switch Tanks Made Easy Work

WHEN inspecting and maintaining oil circuit breakers, it is often awkward and difficult to raise and lower the oil tanks when they are inclosed in restricted compartments. While on a visit to a neighboring utility, one of the representatives told me his company was developing something that would do away with the hazard and hard work connected with handling heavy-switch oil tanks. I assured him that I was interested in the subject and would be glad to see this device. He informed me, much to my disappointment, that it was a secret that they were not ready to divulge. However, I returned with just the bare idea and the thought that if they could develop something along that line, there was no reason why we could not do as well.

Our station mechanic is one of those rare individuals who, in spite of limited educational advantages, is quite a genius. I related my story to him and then asked him if he thought he could make something that would answer the purpose. As usual, he replied that he believed he could. In the course of time, out of odds and ends about the station, he developed the tank-handling device, shown in the figures, which has saved us a great deal of

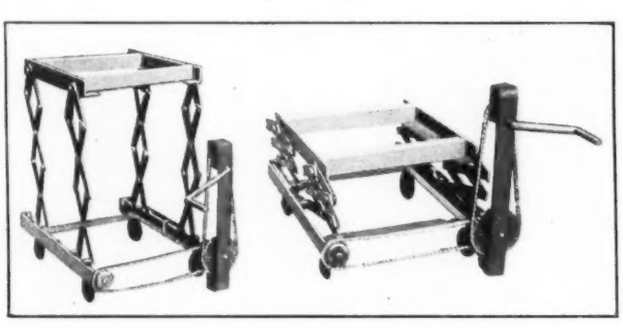
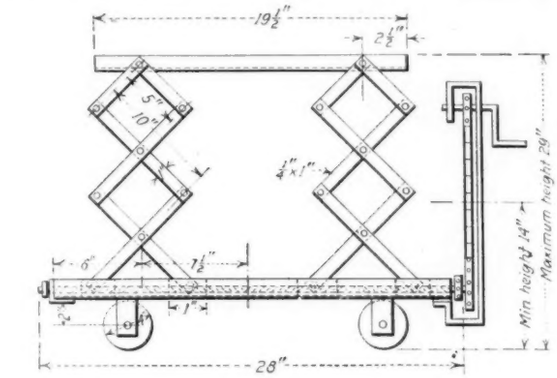


Fig. 1—Tank lifter in raised and lowered positions



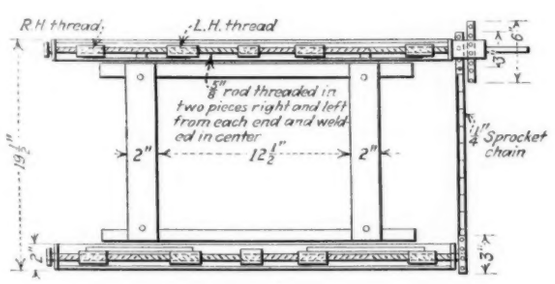


Fig. 2—Details of tank-lifting construction

back-breaking labor and rendered the handling of switch oil tanks a safe and light operation.

A larger and proportionately heavier unit was made for our street-car barn for the purpose of raising and lowering motors and car axles. From experience we find that for car-barn work the gear ratio should be selected carefully, otherwise it will be found difficult to raise the load when the device is lowered to the extreme position. In fact, it is best to arrange a stop to prevent reaching the lowest position.

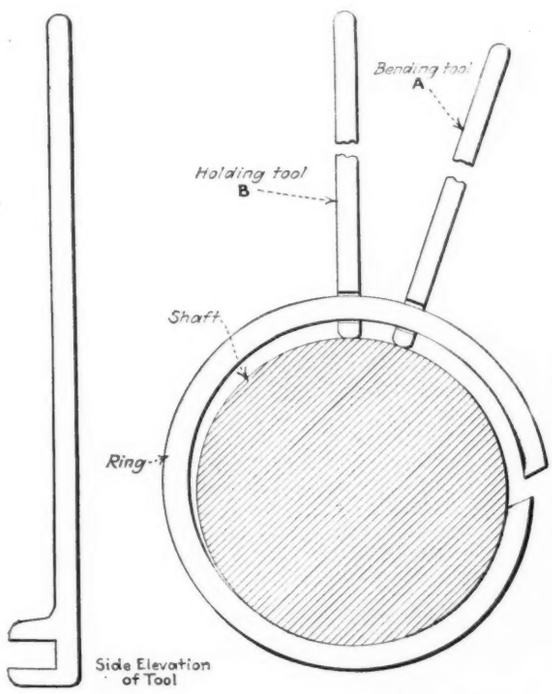
The two photographs, Fig. 1, show the device in a raised position ready to take the weight of the tank, and in the lowered position. The detailed diagram, Fig. 2, gives general dimensions for those who may care to build one. It may be necessary to alter the over-all dimensions to suit particular conditions. By way of explanation it might be added that our mechanic did not need the sketch. He made the device first and let us draw the sketch afterward. J. JACOBS.

Columbus, Ga.

Making Snap-On Oil Shredding Rings Hug the Shafts

SOME shaft bearings are made with snap-on sling rings, instead of wipers, to throw the oil off the shaft at a point inside the housing and thereby prevent its creeping out of the bearing ends along the shaft. These snap-on rings are generally slipped on the shafts before they are laid into the bearings, but it occasionally happens that the shaft must be laid in first and the rings snapped on afterward.

While installing some shafting recently where many of the rings had to be installed after the shafts were laid in and the bearings closed up, we encountered the problem of making the rings hug the shafts. Hammering did no good and only made the rings open up still more, and pliers would not serve because those having noses thin enough to grasp the rings were not strong enough to bend them with the required twisting motion, and those strong enough to bend the rings were too thick-nosed. After considerable experimenting the little tools shown in the accompanying sketch were made and were



Tools used to close in oil shredding rings to make them hug the shaft

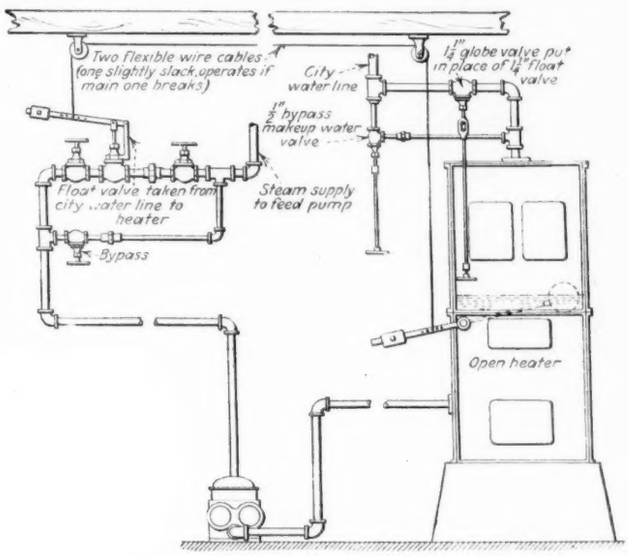
found to serve the desired purpose satisfactorily. It will be seen, by referring to the illustration, that by holding the ring back with the holding tool *B* and pushing forward on the bending tool *A*, the ring will be made to assume a smaller circular form. The rings usually have enough temper to make them spring tightly against the shaft when the tools are removed. These little tools may be made from flat stock by just filing out for the "notch," or they may be made from round stock by welding the grip lugs on.

With these little tools, we were able to solve a rather vexing problem, and it occurred to me that it might prove helpful to other engineers. H. H. ILER.

Newberry, S. C.

How the Heater Makeup Valve Was Used as a Feed-Pump Regulator

IN THE operation of our boilers we had trouble in keeping a normal water level and we were losing large amounts of hot water owing to the heater overflowing into the sewer. The firm could not see the advantage of a feed-pump regulator and besides times were slack, which meant that I could not get it then anyway. So it was


Two flexible wire cables (one slightly slack, operates if main one breaks)
City water line
1" 1/4 globe valve put in place of 1/4" float valve
1" bypass makeup water valve
Float valve taken from city water line to heater
Steam supply to feed pump
Bypass
Open heater

Connections to heater and feed-pump control

up to me to use whatever I had lying around and try to overcome the trouble.

Our load was fairly steady and all the returns were trapped and returned to the heater. The feed pump was manually controlled; that is, whenever the fireman noticed it, he would speed up or slow down the pump as the boiler required. Now if the fireman was a little careless and had the feed pump running too slowly, the hot water coming from the returns would of course overflow into the sewer. Then, if he needed more water he would speed up the pump, which in turn would cause the level of the heater to lower and thereby open up the float-operated valve on the city water line and let cold water into the heater.

When the water in the boiler got to the proper level, the fireman would slow down the pump and try to keep it at a speed that would maintain a constant water level in the boiler, but this was practically impossible. To overcome this trouble we decided to make the changes shown in the illustration.

The float-operated valve was taken out of the city water line and replaced by an ordinary globe valve, which was kept shut at all times and was meant for emergency use only. The float valve was put in the steam supply line to the feed pump and was arranged to operate from the float in the heater by means of a cable, as shown. When the water level in the boiler was being maintained a little lower than half a glass, the makeup valve was cracked open and extra feed allowed to enter the heater slowly; in this way no effect is noticed on the boiler pressure due to cold water entering the heater.

The feed water now enters the boiler at a temperature of between 190 and 210 deg. and, needless to say, no more hot water finds its way to the sewer.

Union City, N. J. RUDOLPH BOETTINGER.

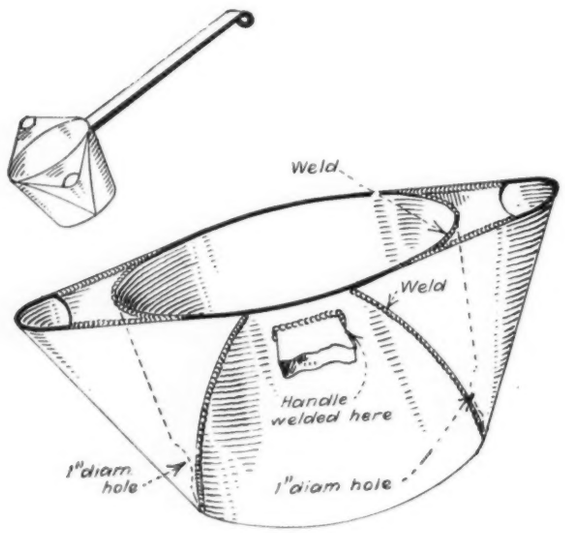
COMMENTS FROM READERS

In which those who agree and those who disagree, with either authors or editors, are afforded an opportunity to express their views

Pouring Babbitt from the Bottom of the Ladle

AFTER reading the article by A. Kendall in the Jan. 17 issue, "Pouring Babbitt from the Bottom of the Ladle," I was prompted to write a description of an improved type of ladle I designed for this work. The ladle body is fabricated from mild steel sheet $\frac{3}{32}$ in. thick, the joints being welded. A useful size of ladle is $4\frac{1}{2}$ in. in diameter at the top, $3\frac{1}{2}$ in. at the bottom, and $3\frac{1}{2}$ in. deep. The handle is made of $\frac{1}{4}$x1-in. iron bar about 20 in. in length.

The ladle, it will be noticed, has two tapered spouts, and in practice these are found exceedingly useful. A small piece of sheet steel is cut to the desired shape and welded on at the top of each spout with an opening of



Babbitt metal ladle made from $\frac{3}{32}$-in. sheet metal with welded joints

suitable size to allow the babbitt to flow steadily and in such a way as to avoid splashing and pocketing of air. Pouring the babbitt from the bottom of the ladle body insures bearing surfaces free from porosity of blowholes, provided the babbitt has been mixed to homogeneity just prior to pouring.

Experience has shown that babbitt metal must be mixed to homogeneity if best results are to be obtained. The best way to obtain this is to stir the metal thoroughly just prior to pouring—not merely by a swirling action around the sides of the pot, but thoroughly mixing the metal from the bottom up and in all parts of the receptacle. If babbitt is allowed to remain still while in the liquid state, it tends to separate into layers. The lead, being heaviest, gradually works toward the bottom and the lighter ingredients to the top. Babbitt-lined bearings poured from metal in such a state, sooner or later develop trouble in service.

Babbitt metal should be melted slowly in a clean iron vessel or graphite crucible and maintained at a temperature between 750 and 850 deg. F. Overheating is not only detrimental to the bearing surfaces, but also causes waste of the tin content through the excessive production of oxide. Where any extensive amount of babbitting is done, it is advisable to have the temperature controlled with an automatic regulator and thermocouple or pyrometer.

Babbitt that contains a high percentage of tin should be poured at a temperature of about 750 deg. F., while that containing a high percentage of lead should be poured at a temperature ranging between 800 and 850 deg. F. Pouring at too low a temperature gives rise to the formation of coarsely granular structures, while excessively high temperatures increase the softness of the alloys without correspondingly improving the tenacity.

In conclusion, it may be said that the best results are obtained by keeping the molten metal thoroughly mixed—especially just prior to pouring—cleanliness, correct temperature of the metal, preheating of mandrels and shells, and reliability of source of supply of babbitt metal.

Manchester, England. E. ANDREWS.

* * * *

An Emergency Boiler-Feed Pump Repair

THE description of an emergency repair to a feed pump, by P. Emerson in the Feb. 7 issue, brought to mind a repair I made some years ago.

Upon my arrival at the plant one morning, the night engineer informed me that one of the feed pumps had broken a piston rod, owing to the heater being pumped dry, causing the pump to race and the rod to break in the threads close to the locknut at the spool.

While we were discussing the probable reason of the heater going dry, the fireman rushed into the engine room with the news that a rod on the other feed pump had broken. Upon investigation it was found to be broken at practically the same place as the first rod and from the same cause. This left us with no feed-water pump and it looked like a shutdown.

I had the main engines slowed to about half-speed and the fires trimmed, in order to make the water that was in the boilers last as long as possible.

The locknut and the broken part of the rod were removed from the spool. As the nut was recessed, there were about three threads left on the broken rod, so a nut was screwed on the end of the rod and jammed there by screwing the short piece of the broken rod into it against the end of the piston rod. The pump was then put in service and operated for two days, until the new rods arrived. The other pump was repaired in the same way.

On looking around for the cause of the trouble, I found that the packing of the valve stem on the automatic makeup valve was dry and hard, causing the valve to stick whenever it was nearly closed. F. W. SPEAR.

McKittrick, Calif.

The Danger of Fire from Lubricating Oils

IN SOME instances a mixture of sperm and castor oil has been used as a lubricant; this is excellent, especially for light bearings, but it has the disadvantage that it is possible for it to ignite spontaneously if by any chance it gets mixed with fluff or dust. Where castor oils or a mixture of other light oils is used, cleanliness around bearings and the absence of oil leakage from the bearings is essential.

Another source of danger is slipping belts. The amount of heat that may be generated on a pulley by a slipping belt is enormous, and as dirty oil frequently collects on the inside of the pulley, the heat generated may be sufficient to cause it to ignite. There is also the static electricity generated as a belt passes around a pulley, which may lead to sparking if sufficient static is generated. In some instances the danger of this has been so great that grounded metal comb has been arranged to make contact with the belt as it rotates and discharge to the ground any static generated. This precaution is essential with pumps handling oil, as the fire risks are greater; it is also necessary to keep the pump well grounded. W. E. WARNER.

Brentford, England.

* * * *

Combustion Control Formulas

IN THE March 27 issue of *Power* F. G. Bailey commented upon an article by Mr. Uehling published in the Feb. 21 issue. The discussion in question is based on the relative merits of CO_2 recorders and their value as a combustion guide in comparison with air-flow steam-flow meters.

Air-flow steam-flow meters have worked out well in central-station plants and other large industries where the plant has been of sufficient size to warrant the constant attendance of a test engineer. This point is essential for the best results in their use. The test engineer must make sufficient Orsat checks and also a thorough study of all variables to obtain good results from these instruments.

Mr. Bailey says, "The best way to determine any quantity is to measure the thing itself." If all variables are made constants, this statement would be more effective, and even should the air-flow variables be made constant, we still have the variables of steam flow. With these existing it is difficult to adjust the air flow to bring about good results.

Soot accumulation on the boiler tubes adds to the resistance of the boiler and consequently increases the air-flow record on the chart with no actual increase in air flow. At the same time the soot decreases the heat transfer and consequently tends to bring down the steam-flow record, and is thus a variable that sends up the air flow and sends down the steam flow. Under these conditions, if the fireman carries the air and steam-flow lines together, he is not obtaining proper combustion results.

Most boilers are equipped with soot blowers, and it may be contended that this variable is eliminated by the proper use of soot blowers. It should be noted, however, that there is a constant change taking place in the resistance of the boiler between the times the soot blowers are used. If this were not so, it would not be necessary to use soot blowers at all.

Increasing the amount of feed water going to the boiler will decrease the steam flow, and if the fireman reduces the air flow to correspond, he is getting incorrect combustion results. If he does not decrease the air flow, the chart will indicate more excess air than necessary. Decreasing the amount of feed water to the boiler will have an opposite result.

Leaks through baffling and in the boiler setting introduce another variable tending to throw off the accuracy of the steam-flow air-flow method.

It is also possible, in my opinion, to have a heavy fire toward the front of the stoker with a considerable number of holes in the fire at the back and yet show correct conditions on the air-flow steam-flow chart. The thick fire toward the front retards the passage of air through the fire. The thin fire at the back causes excess air in this portion of the furnace, yet the total air passing through the grate may be correct for the quantity of steam being made, but due to poor mixture combustion conditions would be extremely bad though the air-flow and steam-flow lines are together.

The CO_2 recorder, under conditions above cited would show the true combustion conditions regardless of the variables named in this article. It is only necessary for the engineer to know the theoretical percentage of CO_2 possible with the fuel being used in the plant, in order to obtain quickly the correct percentage of excess air been carried. WALTER C. EDGE, Vice-President,

Philadelphia, Pa. The Paul B. Huyette Company.

* * * *

Reducing the Speed of a Direct-Current Motor

IN M. E. WAGNER'S method of reducing the speed of a direct-current motor, described on page 602 of April 3 issue, the diagram does not show any means of discharging the field circuit when the switch is opened. There should have been clips provided on the switch to connect the field coils through a high resistance when the motor is disconnected from the line. This is the usual arrangement used to prevent high voltages being induced in the field windings when the circuit is broken under full voltage.

The fact that the high voltage induced in the field coils is momentary frequently causes the danger from this source to be overlooked. In the installation referred to the field circuit might be broken many times before an insulation failure occurred. Then this failure might happen at a time that would lead to believing that the defect was produced by some other cause.

Philadelphia, Pa. WALTER S. GRISCOM.

[On small motors the field discharge voltage is not of a value that will prove disastrous to the machine's insulation. With the earlier types of manual starters the field winding was connected across the line and was broken any time the switch was opened when the starter handle was in the off position. The practice apparently did not cause any trouble. The machine referred to by Mr. Wagner is of small capacity and could be expected to operate satisfactorily under the conditions indicated. On a large machine, if the field circuit is to be opened during normal operation of the machine, means should be provided to connect the field winding through a resistance when it is disconnected from the line. This is the general practice followed on synchronous motors. The discharge voltage obtained when the field circuit is opened will

depend on the design of the machine. With some of the earlier designs having very heavy field winding, the discharge voltage was high and destructive even for a machine of five horsepower rating. This, however, is not true for machines of modern design and fairly high speeds.—Editor.]

* * * *

Can a Throttling Governor Be Applied to a Corliss Engine?

IN HIS inquiry in the Jan. 3 issue as to the practicability of using a throttling governor on a Corliss engine, O. M. Hamilton does not give the type of his present governor, whether flyball or flywheel.

The usual type of flywheel governor gives close regulation of the engine speed, but the following troubles can arise and make it unsteady: If the pin on which the governor arm is carried, becomes dry, it will bind the eccentric, and when the governor arm does move, it will move too much and cause racing. If the spring has too much tension, it will tend to make the governor sensitive and cause racing.

Other causes of poor regulation may be found in the admission valves. If they become worn, they will pass steam after cutoff takes place. Also, there must be no lost motion in the valve links, as the travel of the valves is short.

I do not think it practical to attach a throttling governor to an engine and have it work in conjunction or parallel with the one in flywheel, but I do not see any objection to placing a throttling governor on the steam inlet and having it take care of the regulation independently of the other governor. If a flywheel governor is used at present and a throttling governor is attached, the old governor should be dismantled or blocked stationary and the eccentric keyed in position. R. K. WALSH.

Port au Port, Newfoundland.

* * * *

Dissociation or Evaporation

IN READING the exposition of Robertson Matthews on "Dissociation or Evaporation," I am led to believe that the engineering profession doesn't need linguists.

Vaporization, although Mr. Matthews does not say so, is a general term for the process of the transformation of *any* substance, either liquid or solid, to the gaseous state. When a solid changes to a gas, as is the case with iodine, we call that process sublimation. When a liquid changes to a gas, as with the case where water is boiled, we call that process evaporation.

I do not see where the intensity of the process is concerned at all. Where speed enters into the discussion of the terms is beyond me. Why should vaporization be a rapid process and evaporation a slow process?

Dissociation, if my physical chemistry doesn't fail me, applies to reversible chemical reactions in which a compound is broken into simpler products which may again unite to form the original compound as the pressure, temperature or concentration is varied.

In my opinion, these terms, as used by Mr. Matthews, are misleading and it seems to me that technical papers should give their readers scientific phraseology in a correct manner. JAY HARRIS.

Detroit, Mich.

London's Electricity Supply

IN THE Dec. 6, 1927, issue, page 907, there is a brief item entitled, "New 360,000-Kw. Generating Station for London." I called the attention of our London correspondents to this in an abstract of magazine articles which we send them at frequent intervals, and recently we received a letter from them commenting as follows:

The article in *Power* for Dec. 6, to which you refer, is somewhat misleading in that it seems to imply that under the recent scheme for the reorganization of electricity supply in the London area, all electricity will be generated at the six stations named. These stations, however, are only those belonging to one undertaking, namely, the London Power Company, which have been selected for continued operation. In all 31 existing stations are to be retained to supply the load in the South East England area, which includes some 8,000 square miles in and around London. The balance of these stations are the property of municipalities and other companies, including the County of London Electric Supply Company, whose Barking station will be one of those to carry the base load.

The arrangements also provide for the building of three stations besides the station referred to at Battersea.

F. W. MARTIN,

Chicago, Ill. Sargent & Lundy.

* * * *

Using Hydrochloric Acid in Boilers

IN THE March 6 issue George S. Irving in commenting on the use of hydrochloric acid in boilers to prevent caustic embrittlement, states that with a zeolite plant in use and the water containing temporary hardness, it might be necessary to cut this plant out as regards the boiler. I assume this to mean that where the finished zeolite treated water showed sodium carbonate in excess of the sodium sulphate, it would be advisable to change the water supply.

I cannot agree, however, with Mr. Irving, inasmuch as the water showing high in temporary hardness can always be given a pre-lime treatment and then finished with a zeolite softener. For example, the following is an analysis of raw water showing exceedingly high temporary hardness, and also an analysis of the zeolite treated water.

	(Grains per U. S. Gal) Raw Water	Treated Water
Temporary hardness ($CaCO_3$)	10.1	.....
Permanent hardness ($CaCO_3$)	3.2	.....
Total dissolved solids	17.2	25.48
Suspended matter	Nil	.....
Calcium bicarbonate ($CaCO_3$)	8.7	.....
Magnesium bicarbonate ($MgCO_3$)	1.17	.....
Sodium bicarbonate ($NaHCO_3$)	Nil	16.94
Sodium carbonate (Na_2CO_3)	Nil	.....
Sodium hydroxide ($NaOH$)	Nil	.....
Calcium sulphate ($CaSO_4$)	Nil	.....
Magnesium sulphate ($MgSO_4$	3.20	.....
Sodium sulphate (Na_2SO_4	Nil	3.78
Calcium chloride ($CaCl_2$)	Nil	.....
Magnesium chloride ($MgCL_2$)	0.60	.....
Sodium chloride ($NaCl$)	3.40	4.10
Iron and alumina (R_2O_3)	0.23	0.23
Silica (SiO_2)	0.43	0.43

In order to decrease the cost of the salt used in regenerating the zeolite softener, a lime treatment is given the raw water filter and then finished with the zeolite softener. In this way a raw water running high in temporary hardness was found desirable for a zeolite softener. This same treatment can be applied to any water running high in temporary hardness, which would be undesirable in producing a high boiler alkalinity if not given some pretreatment to reduce the content of calcium and magnesium bicarbonates. D. C. CARMICHAEL,

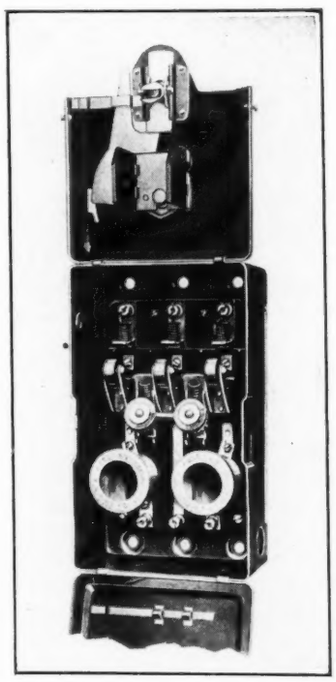
Pittsburgh, Pa. Cyrus Wm. Rice & Company.

PLANT EQUIPMENT NEWS

New and improved equipment in power and industrial plant fields, and new applications of existing equipment

Cutler-Hammer A.C. Manual Starter

A NEW manually operated across-the-line A.C. motor starter (CH-9115) is announced by The Cutler-Hammer Manufacturing Company, Milwaukee, Wisconsin. The



Starter with cover open

new starter embodies the latest improvements, including overload cutouts giving complete motor protection, roller-type contacts, and small-sized safety, dustproof inclosing case.

The roller-type contacts are of the double-break type, cadmium plated, and are arranged to break the arc in two places, tending to increase the life of the contacts. In addition, the contact rollers turn after each operation to present a new contact surface for the next operation.

Complete motor protection is obtained during both the starting and running periods. The thermal overload cutouts provide the necessary time interval to take care of starting inrushes without shutting down the motor.

The inclosing case is dustproof, and the cover is in two parts. This permits opening the lower section only, for replacing fusible links in the thermal overload cutouts. The cover can be opened only when the starter is in the "off" position and all current carrying parts are "dead." Installation can be made without removing the panel from the case, and all parts are readily accessible for inspection.

Carrier Unit Air Conditioner

THE unit air conditioner illustrated is a recent addition to the line of air conditioning and drying equipment manufactured by the Car-

Fig. 1—View of unit humidifier

rier Engineering Corporation, 750 Frelinghuysen Ave., Newark, N. J.

The unit, which is portable and self-contained, is designed to wash the air, to reduce or increase and control the atmospheric humidity, to heat or cool the air according to requirement and to circulate it uniformly through the rooms to be conditioned.

Referring to the illustration, the unit consists essentially of a centrijector with spray nozzles, a fan to draw the air through the spray, eliminators to remove the entrained moisture from the air and heaters to raise the temperature of the air to the required point. The centrijector, which serves the purpose of a pump, is a hollow tube through which the water is drawn by centrifugal action, produced by rotation, from a chamber in the bottom of the unit, and discharged through a series of six spray nozzles mounted at the top of the tube. At the bottom the hollow tube is carried in a self-aligning oilless bushing, supported by rubber rings.

The air is drawn into the unit by means of a fan, through a series of baffles in the side of the housing directly below the level of the spray nozzles. From the fan the air passes through the eliminators, a series of metal plates arranged across the entire area of the cabinet which frees the air of entrained moisture. From the eliminator the air passes through the heater, which is made up of continuous copper tube, non-corrosive, extended surface heating sections and thence to openings on any or all sides of the cabinet.

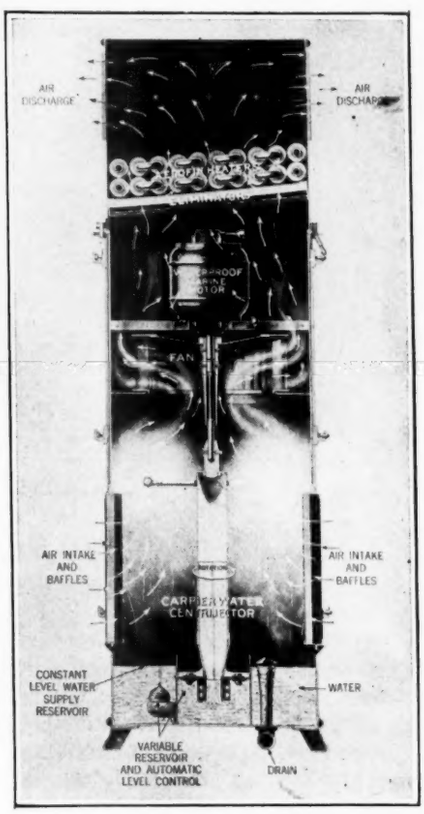


Fig. 2—Section of unit

The motor used to drive the fan and centrijector is totally inclosed and moisture proof, with a corrosion-resisting, nickel-steel shaft carried on ball bearings. These bearings also carry the weight of the fan and centrijector, the latter being connected to the motor through the fan by means of a flexible coupling carried in a safety sleeve which limits the deflection.

Automatic humidity and temperature control instruments are provided with each unit to meet the particular installation requirement.

The unit illustrated has a capacity of 2,500 cu.ft. of conditioned air per minute. The cabinet is 2 ft. 6 in. by 2 ft. 8 in., and 7 ft. 8 in. in height. The casing is an assembly of die-stamped and rolled steel plate.

"Economy" Centrifugal Pumps of Improved Design

QUITE recently the Economy Pumping Machinery Company, of Chicago, has redesigned its entire line of centrifugal pumps. In the general-service single-stage centrifugal pumps, which are of the double-suction type, numerous refinements have been made both in the mechanical and the hydraulic design, so that, depending upon capacities, efficiencies of 80 to 85 per cent are to be anticipated. These new pumps are being designed for standard motor speeds of 1,750 r.p.m. for 100-ft. head and 1,750 or 3,600 r.p.m. for heads up to 200-ft. All the single-stage pumps are of the horizontal split-case design equipped with sealed ring-oiling bearings, the bearing brackets being cast with the case.

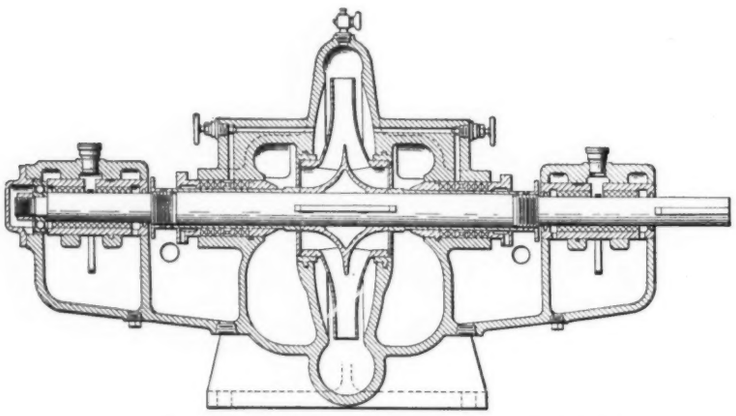


Fig. 1—Double-suction single-stage pump

Wearing rings are designed with male flanges that lock them in the case. They are of the ell shape, which takes advantage of the centrifugal action of the water to prevent leakage. Shafts of alloy steel are protected by cast-bronze sleeves in that part of the length exposed to the liquid.

The packing glands are split and arranged to deflect any gland leakage into the drip yokes. Large pumps are equipped with ball-thrust bearings, and pumps of 3 in. and under are fitted with ground thrust collars.

To supplement the new line of double-suction single-stage pumps, several sizes of hydraulically balanced multistage centrifugal pumps have been designed specially for boiler feeding, city water works and other heavy-duty high-pressure services. Discharge pressures range from 100 to 500 lb. per sq.in., and capacities from 100 to 500 gal. per minute.

These pumps are of the single-suction design without diffusion rings, but with a spiral or volute in every stage. One-piece bronze diaphragms are used between stages. By tongue and groove these diaphragms fit into the case, so that there is no leakage between the case and the diaphragm.

The hydraulic balancing device is of the disk type located at the outboard end of the pump, as at *A*, Fig. 2. Leakage at the high-pressure stuffing box is controlled by a needle valve on the water seal. Bronze stuffing glands of the split type deflect leakage into the bearing yoke. Grooved sleeves on the shaft return the leakage within the gland and thus prevent the external throwing of water.

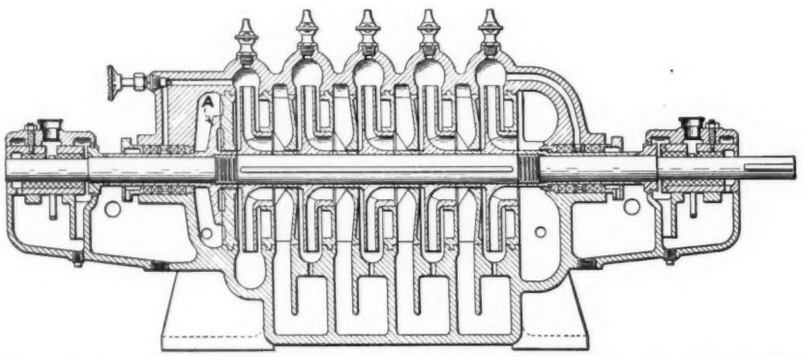


Fig. 2—Cross-section through multistage single-suction pump for high-pressure service

Bearings are of the ring oiling type, sealed to prevent the escape of oil or the entry of dirt or water. Bearing shells of cast iron, babbitt lined, are supported on brackets cast with the case. They are fitted with spring oil-hole covers and oil level cups. Bronze sleeves extending through the stuffing boxes protect the pump shaft wherever exposed to the water.

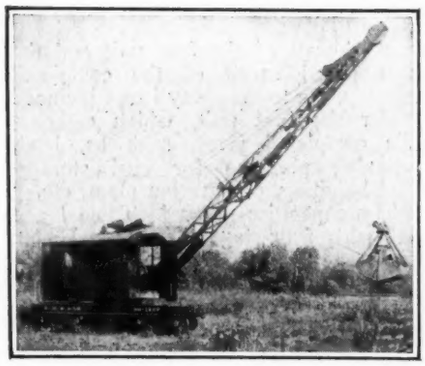
In these new pumps the head per stage is kept low in order to secure maximum efficiency with low water velocities. Light rotating elements are thus permissible and the horsepower and efficiency curves are comparatively flat. Low water velocities tend to insure long life and low maintenance cost.

"American" Three-Speed Gasoline Crane with Automotive Shift

FLEXIBILITY equal to that of steam cranes is the outstanding feature claimed for the new "American" gasoline three-speed crane, made by the American Hoist & Derrick Company, 63 South Robert St., St. Paul, Minn. This new crane has an automotive shift that works like the transmission on an automobile; that is, low gear for a powerful start, intermediate for average crane work

and traveling, and high gear for rapid traveling. The transmission is operated with a foot clutch and an automotive gear-shift lever that has been placed at the front right-hand corner of the deck to give the operator a clear view of the work. All transmission and bevel gears connecting with the driveshaft are inclosed in an oiltight case.

The friction clutches are of the compound lever umbrella action type that expand outwardly against the friction groove of the drum. To make contact, the heads travel only a fraction of an inch, so that the gear-shift operation is easily accomplished. The friction heads are faced with a woven-wire asbestos fabric that, it is claimed, will not char from overheating and will not swell when wet.



Gasoline three-speed crane in operation

As the title implies, the new crane has been designed and built for operation with a gasoline engine, using four cylinders. To minimize vibration, the engine is fitted down into the heavy revolving deck casting and is bolted solidly to it.

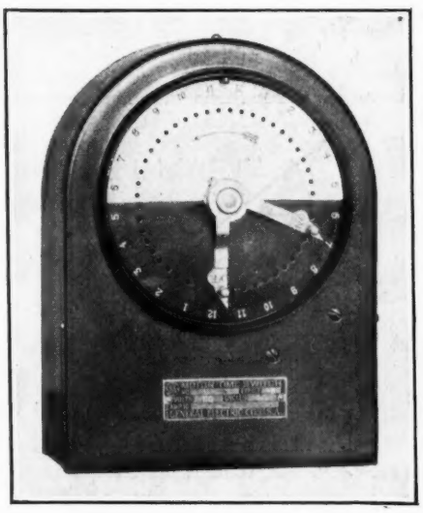
The machinery deck revolves on bronze-bushed conical steel rollers, on which the weight of the deck, boom and load is carried. No load falls on the roller axles, their sole function being to space the rollers. This construction makes slewing easy and tends to reduce friction when revolving the load. The machinery deck is locked to the car body at the outer circumference of a bull gear by an interlocking gib ring, to prevent teetering and rocking and give uniform stability.

Fabricated of structural steel with 15-in. girder side sills, the car body is mounted on two four-wheel swiveling trucks. Traveling power is transmitted to the axles through universal couplings and cast-steel bevel gears, the mechanism being inclosed in a dustproof case.

Capacities range from 12 to 30 tons, the ratings being based on the capacity on the intermediate gear. An air compressor for air brakes and a generator for lights are supplied with the equipment if required.

General Electric Automatic Time Switch

A NEW small motor-operated automatic time switch for use in controlling alternating-current circuits, where the load is less than ten amperes, has been announced by the General Electric Company. This is intended for the control of window lighting, electric signs, protective lights and many industrial applications where circuits are required to operate regularly during a certain portion of each day.



Motor-operated time switch

The new switch, as shown in the figure, has a revolving dial divided into 24 parts, half of the dial being finished in white enamel and the other half in black, to represent day and night hours. Two arms, registering on the dial, can be set at half-hour intervals to control the making and breaking of the load circuit, the maximum time interval being 11½ hours.

The time keeping element of this switch is a small disk-type synchronous motor. The motor operates from the alternating-current supply and will keep the exact time so long as the circuit maintains its average rated frequency. The motor has a consumption of three watts, supplying ample power for operating the clock mechanism and contactors.

A single-pole contactor is used. The contacts are of silver and are mounted in brushes that bear directly on the control cams. The switch may be operated by hand, after which the time must be checked. It is contained in a sheet-metal case provided with the usual knockouts for the installation of conduit.

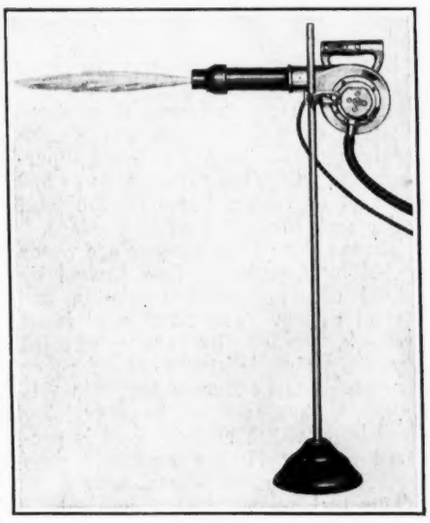
Clements Portable Blow Torch

THE Clements Manufacturing Company, 601-613 Fulton St., Chicago, Ill., recently added to its line of portable cleaners and blowers a motor-driven blow torch, illustrated.

The torch is designed to give a temperature of 1,600 to 2,300 deg. F. and is especially adapted to operation of welding, brazing, annealing and soldering.

The torch is connected directly to the city gas line, and by means of a special air valve control to regulate the flow of gas and air for the temperature desired, an even flow of gas is maintained, regardless of the pressure on the gas main. The air valve is so constructed that all air can be shut off, making it possible to maintain a low temperature when desired.

The ball bearing universal motor with which the torch is equipped can be supplied in any voltage from 100 to 275.



Motor-driven gas blow torch

CORRECTION—In the description of the Wellman gate and globe valves, in the April 17 issue, the manufacturer's name was inadvertently omitted. These valves are made by the Wellman-Seaver-Morgan Company, 7000 Central Ave., Cleveland, Ohio.

ELECTRICAL ENGINEERS STUDY

Design and Operation of Gould Street Plant

AT BALTIMORE MEETING

THE Gould Street Station of the Consolidated Gas, Electric & Power Company, its design and operation, was the subject for one session of the American Institute of Electrical Engineers Regional Meeting, held in Baltimore, Md., April 17 to 19. Three papers were presented: "The Gould Street Generating Station," by A. S. Loizeaux; "Design Studies for Gould Street Generating Station," by F. T. Leilich, C. L. Follmer and R. C. Dannettel; "Operating Experiences at Gould Street Station," by A. L. Penniman, Jr., and F. W. Quarles.

This station, which began operation in January, 1927, is in Baltimore and occupies the site of an old plant built twenty years previous. The units in the new plant have a rating twelve times the capacity of the old ones, with a coal rate for the new plant less than one-half that for the old station. The new plant is designed for four 36,000-kw. 80 per cent power factor units. One unit has been in operation for about sixteen months and a second is nearly ready to go into service. One boiler is provided for each turbine.

Each boiler is designed to have a maximum capacity of 520,000 lb. of steam per hour, delivered at a drum pressure of 450 lb. gage and a temperature of 725 deg. F. at the superheater outlet. This corresponds to 550 per cent of rating, based on the total boiler and furnace heating surface.

Three sides of the furnace are water cooled by fin-tube surface backed by special tile, rock-wool insulation and a steel casing. The front wall is of firebrick, cooled by the preheated secondary air admitted to the furnace through ports at sixteen levels in this wall. A separate coal pulverizing plant is provided, and the coal is prepared so that 70 per cent will pass through a 200-mesh screen.

The turbine is a 13-stage Rateau impulse machine of 36,000 kw. capacity and drives the main generator through a flexible coupling. It is a modified form of a turbine of lower normal rating of the non-bleeding type. The initial stages, however, have been opened up to pass the additional steam used in bleeding. Steam is supplied at a normal pressure of 390 lb. and a total temperature of 700 deg. F. Steam is bled at the third, fifth, eighth and tenth stages at full-load pressures of 193, 99, 30, and 9 lb. absolute respectively. The turbine is designed for highest efficiency at 25,000 kw. load; and when bleeding steam at four points the unit can produce a net station send-out of 36,000 kw., which is the company rating of the machine. A considerably larger output can be produced by bleeding at the two lower points only.

When the plant was first started, considerable trouble was had with the pulverized-coal preparation equipment on account of the moisture in the coal. The drying is now done by heating the makeup air to the circulatory system. This air is heated by high-pressure steam. The mill drying system is performing satisfactorily and has practically eliminated the troubles incident to wet coal. In regular operation the mill drier reduces the moisture content in the coal from 6 per cent entering the mill to 1.7 per cent on leaving.

The power used in grinding and transporting the pulverized coal averages about 19.6 kw.-hr. per ton of 2,000 lb. The maintenance cost of the pulverizing equipment is about 13.9c. per ton.

Investment Costs per Kilowatt Capacity

Throughout the design of the plant the object was to secure maximum reliability with minimum total costs per kilowatt-hour. By total costs is meant not only operating labor and superintendence, maintenance and fuel cost, but fixed charges on the investment. This criterion was used in the choice of equipment, the cost of the apparatus being weighed against its ability to reduce production costs.

Table I gives the actual cost of the first unit, and the estimated costs of three additional units; the estimated cost of the completed plant of 144,000 kw. being $88.26 per kilowatt.

The wide spread between the cost per kilowatt of the first unit and the cost per kilowatt of the completed plant is due to the many items included under the first unit, which embrace the completed plant, such as, land, relieving platform for coal storage, coal handling, preparation plant, etc.

The capacities given in Table I are net with four-stage bleeding. Under two-stage bleeding conditions the capacity is increased considerably and a net send-out of 40,000 kw. is readily obtained from each unit and will be obtained in the event of need, for peak-load conditions. Figuring this higher capacity, the investment costs become as in Table II.

The investment figures given include all expenses of every nature in connection with this plant, covering such items as preliminary engineering, old buildings used, interest during construction and during tuning-up period, also a portion of the floating equipment of the company properly allocated to serve this plant.

Five failures of fin tubes constituting the back furnace wall have occurred. These tubes have all failed in the same manner and almost at the same spot; namely, the outside of the top bend of the rear wall tubes near the sides of the furnaces. In one case a large bulge was noticed before an actual rupture occurred. The water circulation is to be investigated to determine whether or not there is considerable difference in rapidity of water circulation in different parts of the back wall. The obtaining of this information will no doubt make possible a satisfactory analysis of this condition.

The main condenser, while of some-

A STEAM PLANT designed to secure maximum reliability with low cost per kilowatt-hour output has been built for $130.05 per kilowatt for the first 36,000-kw. unit. When the plant is completed with four such units the cost will drop to $88.26 per kilowatt. The design and operation of this station was the subject for one session at a recent A.I.E.E. meeting, the high points of which are given in this article.

what radical design in that the tubes are rolled into the tube sheet at both ends, has given but little trouble. The noticeable leaks that have occurred have been few. In spite of the fact that the circulating water is high in salt content, we have been able to maintain the solids in solution in the condensate at the low value of two parts per million and the electrical resistivity 1,000,000 ohms per centimeter cube.

Over-All Performance

Whereas the plant delivered power to the bus for the first time on Jan. 4, 1927, the amount of generation for the first three months was comparatively small, because of the decision to concentrate attention on those details which most affected the dependable operation of the plant. For this reason these three months have been neglected in drawing up Fig. 1, which graphically illustrates the amount of generation per month, the average weighted daily load factor and B.t.u. consumption per kilowatt-hour of net send-out. The amount of generation reflects not only the tuning up of the plant, but also the manner in which steam generation at Baltimore is affected by the river flow at the hydro-electric plant of the Pennsylvania Water & Power Company, from whom a considerable amount of power is purchased. Two curves are shown on Fig. 2, one of which is that of the predicted performance of the plant in B.t.u. required per net kilowatt-hours of station send-out plotted against weekly load factor in per cent; the other curve is that of the weekly performance in B.t.u. actually used, plotted in the same manner. The points plotted for actual performance, of course, show quite a wide variation, not only because of the changes being made in the plant during the year, but also because of the fact that there are large coal storage spaces between the point at which the coal is weighed and the point of consumption, a comparatively small error in estimation of the coal in these spaces causing a much larger error in the consumption figures, the greatest error occurring when the consumption is least. It is expected that the installation of automatic coal scales to weigh the coal entering the mills will greatly decrease this error, since the effect of an error in the estimation of the raw coal bunker will be eliminated from the result, the pulverized coal bunkers then being the only storage space affecting the accuracy of the consumption figures. The monthly figures are somewhat more accurate since the amount of coal used is about four times as large and the error introduced by bunker estimates is thereby made one-fourth as much. It is expected that the predicted performance will be approached very closely.

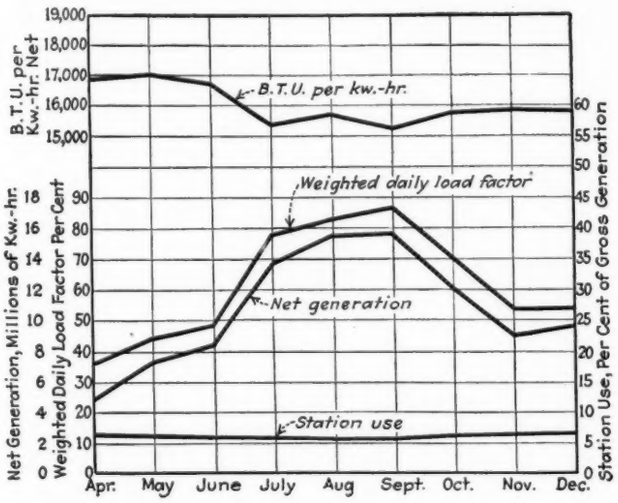

B.T.U. per Kw.-hr. Net
B.T.U. per kw.-hr.
Weighted daily load factor
Net generation
Station use
Net Generation, Millions of Kw.-hr.
Weighted Daily Load Factor Per Cent
Station Use, Per Cent of Gross Generation
Apr. May June July Aug Sept. Oct. Nov. Dec.

Fig. 1—Performance of Gould Street Station for nine months in 1927

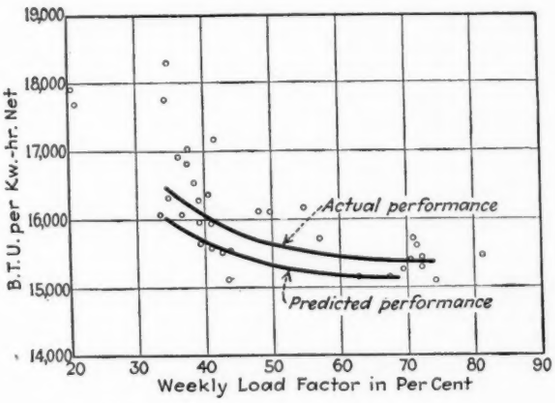


Fig. 2—Relation of predicted to actual performance

Changes and Adjustments

The plant has been subject to the usual minor changes and adjustments during the initial period of service. None of the troubles experienced were unsurmountable. They can all be traced to the fact that most of the equipment affected was of the largest sizes that were obtainable, operating in many instances at rather high capacities. This introduced some problems that were entirely new, it being necessary for the manufacturers supplying equipment to do a certain amount of development after their apparatus was placed in service. While such a procedure is necessarily slow, it is felt that the manufacturers affected have made a satisfactory record in solving their individual problems and in making necessary changes and connections.

The actual performance has approached fairly close to the anticipated, and it is expected that, when the air-heater performance is improved and the effect of the recent increase in steam temperature is realized, the anticipated performance will at least be met and possibly slightly bettered.

Discussion

In the discussion attention was called to Gould Street Station being the first one boiler per turbine plant in this country. For this reason there were in the station a number of features that represented distinct advance in power-station design. In the design of the boiler 4-in. tubes 24 ft. long were used, which, for 450 lb. pressure, was a departure from the usual practice in boiler construction. These long tubes involve new problems in liberating the steam from the water. When the plant was first started, trouble was experienced with wet steam. This has been overcome by installing a specially designed system of baffles in the steam drum.

The experience from starting the pulverized coal equipment at Gould Street led to the conclusion that much trouble would be avoided if such plants were put into service in warm weather instead of the winter months.

A. L. Penniman, when discussing the experience with 725-deg. F. steam, expressed the opinion that there seemed to be no reason why steam temperatures could not be increased to 800 or 850 deg. F. When the present difficulties are overcome at Gould Street Station, it is the engineer's intention to try operating at temperatures higher than the present 725 degrees.

TABLE I.—COSTS BASED ON CAPACITY FOR FOUR STAGE BLEEDING OF THE TURBINE

	1 Unit (Actual)	2 Units (Estimated)	3 Units (Estimated)	4 Units (Estimated)
1. Investment cost as per report of June 20, 1927	$4,681,821	$7,396,224	$10,090,322	$12,709,909
2. Capacity—kw.	36,900	72,000	108,000	144,000
3. Cost per kw.	$130.05	$102.73	$93.43	$88.26

TABLE II.—COSTS BASED ON CAPACITY FOR TWO-STAGE BLEEDING OF THE TURBINE

	1 Unit (Actual)	2 Units (Estimated)	3 Units (Estimated	4 Units (Estimated)
1. Investment cost as per report of June 20, 1927	$4,681,821	$7,396,224	$10,090,322	$12,709,909
2. Capacity—kw.	40,000	80,000	120,000	160,000
3. Cost per kw.	$117.05	$92.45	$84.08	$79.44

French Imports of Power Equipment

Factors responsible for falling off in certain lines.
American built compressors lead.

THE United States Department of Commerce has just issued a report by Franklin P. Waller, Assistant Trade Commissioner, Paris, dealing with the "French Market for Industrial Machinery." This includes, among other items, steam and internal-combustion engines, boilers, pumps and compressors.

Disregarding the abnormal post-war years 1919 and 1921, France's industrial machinery imports from the United States had increased until in 1925 they were almost double the 1913 volume. During 1926 the situation altered slightly, machinery imports from the United States declining from the 1925 volume by nearly 8 per cent and imports from Great Britain slumping 35 per cent, while imports of German machinery expanded by 17 per cent. This is partly explained by German reparations and partly by the fact that during the last few years a number of American manufacturers have found it advantageous, because of lower production costs, to establish manufacturing branches in France, and in some instances South American orders have been executed from these branches. These manufacturers greatly increased their production to meet local demand, and this has worked a corresponding reduction in imports from the home plants. In addition, there has been an increasing tendency for some American manufacturers to have their machines or parts made by manufacturers in France on a royalty basis.

Waterwheels and Turbines

French imports of waterwheels and turbines during 1926 were almost four times the 1925 volume; as compared with 1913, they were 38 per cent less in quantity but over 5 per cent greater in dollar value.

Germany was by far the most important contributor to the 1926 imports, with the United States, Great Britain and Switzerland following, in the order named.

Steam Engines

The local demand for steam engines has considerably increased during recent years, and this has been met largely by local manufacturers. Steam engines, owing in great measure to the high cost of fuel oil, are still employed for many purposes where oil engines are now used in the United States. French imports of steam engines, however, both marine and stationary, have dropped off since the war, amounting to approximately $638,000 in 1926 and to $505,000 in 1925, as compared with $1,611,000 in 1913.

Imports of stationary steam engines from the United States during 1926, though only 10 tons as compared with 19 tons in 1925, were valued at approximately $11,180 as against nearly $7,500 in 1925. The preponderance of imports of stationary steam engines is from Switzerland, amounting in 1926 to 417 metric tons, valued at $394,470.

Internal-Combustion Engines

The local production and consumption of internal-combustion engines has greatly increased during recent years. Imports of these engines continue to be important, amounting to $1,097,000 in 1926 and to $1,209,000 in 1925, as compared with $1,318,000 in 1913.

Great Britain was the most important supplier during 1926, furnishing 648 metric tons, valued at $328,730, and was followed by the United States with 395 tons, valued at $196,670.

Steam Boilers

Of the boilers used in France, 90 per cent are made locally. French imports of boilers in 1926 amounted to only 829 metric tons, valued at $181,000, whereas French exports in this class reached 3,480 tons valued at $614,000.

Pumps and Compressors

The United States and Great Britain were the two more important sources for importation of steam pumps in 1926, supplying 83 per cent of the total value in this class. For pumps other than steam, Germany was by far the most important source, supplying almost 39 per cent of French import values in this class. The United States, Switzerland and Great Britain followed in the order named.

It was estimated that during 1925 more than $1,000,000 worth of air compressors were sold in France, over half of which were imported. During 1926 their use increased so considerably that sales for the year were estimated at more than $1,800,000. Local manufacturers, however, increased their production to meet this demand, so that imports dropped as between 1925 and 1926, by about 38 per cent in both weight and value.

The United States is the principal exporter of compressors to France, supplying in value almost double that from all other sources combined. Despite the fact that an American company manufactures a large number in its French plant, compressor imports from the United States were valued at $431,780 in 1925 and at $322,120 in 1926. This drop of 26 per cent compares with one of 83 per cent in imports of British compressors ($165,137 to $28,026) and a drop of nearly 43 per cent ($120,250 to $68,820) in imports of Swiss compressors.

Omit Spare Capacity to Reduce Power Costs

AT THE regular monthly meeting of the Philadelphia Section of the Association of Iron and Steel Electrical Engineers, D. M. Petty discussed the possibilities of keeping down the cost of power generation equipment in industrial plants. The suggestion was made that where 100 per cent reliability in power need not be provided for, it is possible to make a considerable saving in the power-plant investment by installing only sufficient equipment to carry the load. The reliability of modern equipment is such that by making minor repairs and adjustments at nights and Sundays a high degree of service continuity can be obtained with any spare capacity in the power plant.

Mr. Petty called attention to the design of one plant without spare capacity where the investment was about $500,000, in which the cost of power with three-dollar coal was 1.44c. per kilowatt-hour. To provide for 100 per cent continuity of service would have cost $250,000 additional and the cost of power would have increased to about two cents. With six-dollar coal these figures become 1.8 and 2.34c. per kilowatt-hour respectively.

It was Mr. Petty's opinion that too much attention has been given to the operating costs of the plant by engineers and too little to the capital cost. In certain classes of plants a considerable expense is incurred to provide against short interruptions of service, when such interruption would cause no loss of production or of profits. As the speaker put it, it would cause only a postponement of production for a short time, which could be easily made up when the plant went into service again.

In plants where continuous processes must be maintained to prevent damage to the product, or where they operate at 100 per cent capacity all the time, provisions to maintain 100 per cent power service are justified. Under conditions where temporary interruptions will not be an item of expense in production, the possibilities of keeping down the power-plant costs by using less space capacity should be carefully considered.

The suggestion was also made that this principle be applied to the purchase of power. It is possible to obtain a better power rate by purchasing it on an off-peak basis. Two things may be done under such a rate: One is to adjust the hours of operation so as never to get on the peak, and the other is to forego an interruption to the power supply during the peak, should such a thing occur. The experience of refrigerating plants that purchase power on an off-peak rate, is that power interruptions are quite rare on account of lack of system capacity during the peak-load periods.

NEWS OF THE FIELD

The editors will welcome the co-operation of readers in reporting interesting happenings, personal or otherwise

New British Project To Link Twenty-Five Power Plants

IMPORTANT proposals have just been made public for the electrical development of central England. The project is the third which the British Electricity Commission, after a careful survey and protracted negotiations, has submitted to the Central Electricity Board with a view to linking up the country by a great chain of power zones, the earlier programs having related to central Scotland and southeast England.

The area now to be organized, at an estimated capital expenditure of $38,170,399 is one of some 7,311 square miles, inhabited by 5,218,146 people. Broadly speaking, it embraces the entire countries of Leicestershire, Northamptonshire, Staffordshire, Warwickshire, Worcestershire, Nottinghamshire, Shropshire, large portions of Derbyshire, and parts of Bedfordshire, Buckinghamshire, Cheshire, Gloucestershire, and Oxfordshire.

In the Midlands there are 46 public generating stations in existence at present. It is proposed, for the purposes of the scheme, to name nineteen of these as selected stations, with an additional six which are to continue working under temporary arrangements with their respective proprietors. By means of the combined operations of these 25 stations it will be possible to satisfy the entire needs of central England. The rest are to be closed or converted, according to circumstances.

The daily base loads will be concentrated on the five stations of four existing organizations. Between them these undertakings already have very extensive statutory powers of supply. These key points of the system are the following: Hams Hall, Birmingham Corporation; Ironbridge, West Midlands Joint Electricity Authority; North Wilford, Nottingham Corporation; Stourport and Smethwick, Shropshire, Worcestershire & Staffordshire Electric Power Co.

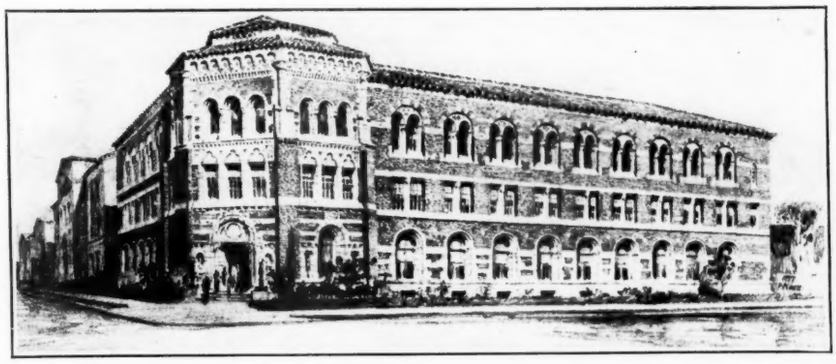
It is proposed that by the winter of 1933-34 the Hams Hall station shall be enlarged by the addition of 30,000 kw. of three-phase 50-cycle capacity, and a further addition, aggregating 150,000 kw. shall be installed prior to the winter of 1940-41. The capacity of the North Wilford station is to be increased by two additions of 50,000 kw. each, the first by 1934-35, and a further addition, aggregating 100,000 kw., will be in operation prior to the winter of 1938-39.

The other selected stations are: Longford, Coventry Corporation; Spondon, Derbyshire & Notts Electric Power Co.; Freeman's Meadow, Leicestershire, Corporation; Hardingstone, Northampton Electric Light & Power Co.; Avon & Hinckley, Leicestershire & Warwickshire Electric Power Co.; Burton, Derby and Stoke owned by their respective corporations; Ocker Hill, Walsall, and Wolverhampton, West Midlands Joint Electricity Authority; and two at Nechells, Birmingham Corporation.

In order that all the stations may be interconnected, it has been necessary to standardize the frequency. In the areas served by the Birmingham Corporation and the Shropshire Power Company, the present frequency is 25 cycles per second, whereas in the other areas the standard of 50 cycles per second applies. In Birmingham especially there has been considerable opposition to the standardization proposal, which might involve serious inconvenience to many important industries.

The Central Electricity Board, to whom the project has to be referred by the Commission, is under statutory obligation to receive representations from all interested parties, and it will then proceed to put it into effect with such amplifications or modifications as may seem desirable. The Commission's fourth scheme, which may be ready by June, will deal with northwest England and north Wales.

Engineering College Created at Southern California



New Engineering Buildings at University of Southern California, Los Angeles, to cost over $400,000

THE demand for engineering education in the southwestern part of California on the part of young men of this region and the need of industries in southern California for centralized and adequately equipped engineering laboratories have led the board of trustees of the University of Southern California to authorize the inauguration of a college of engineering.

Philip J. Biegler, professor of electrical engineering at the University for the last five years, has been appointed dean by President Rufus B. von Kleinsmid. The new college, which will open its doors in September, will be made up of five major divisions with separate chairmen as follows: Chemical Engineers—Prof. Willard W. Scott; Civil Engineering—Prof. Robert M. Fox; Electrical Engineering—Prof. Philip S. Biegler; Mechanical Engineering—Prof. Thomas T. Eyre; Petroleum Engineering—Prof. Allan S. Sedgewick.

In addition to the four-year courses leading to degrees of Bachelor of Science in any of the divisions of engineering and a Master's degree for graduate work, there has also been established the degree of Civil Engineer for distinction in the practice of engineering.

Unit Heaters Discussed By A.S.H. & V.E.

On April 16, the New York Chapter of the American Society of Heating and Ventilating Engineers held its last regular meeting of the season at the Builders Exchange Club, 2 Park Avenue, New York City. The meeting was opened with the announcement that H. B. Hedges had been elected president, E. J. Ritchie, vice-president, E. W. Beebe, treasurer, and E. C. Johnson, secretary of the chapter for the coming year.

Thornton Lewis, president of the York Heating & Ventilating Corporation, presented a paper on unit heaters and showed by pictures of smoke-bomb tests in industrial buildings the air circulation that results from various types of unit heater installations.

Mr. Lewis indicated the heating performance obtainable from high-velocity floor-mounted unit heaters by citing the results of a large number of tests in industrial plants, all of which showed a temperature rise per foot height of building of less than one degree Fahrenheit. He also presented the results of tests intended to show the relative economy of floor and suspended types of unit heaters. He stated that it had been his experience that on the average it would cost 20 per cent less in coal to heat a building with unit heaters than it would with direct radiation.

Tunnel for Scottish Power Project Nears Completion

In the course of work on the Lochaber hydro-electric power development in Scotland, the contractors have just joined the two sections of one of the largest water tunnels in the world. Operations have continued from each end for 18 months, and when the workmen met it was found that, although they were operating from base lines twelve miles away, they met within one inch of the true center. The Lochaber power project, upon which construction began in 1924, will provide power for the works of the British Aluminum Company, and is estimated to cost $30,000,000. Loch Laggan will be linked with Loch Treig, the head waters of the Spey will be tapped, and the surface of Loch Treig will be raised 40 ft. by the diversion of all the collected water into it.

I. & S. E. E. to Hold Convention in Chicago

June 25 to 29 are the dates for the 24th Annual Convention and Iron and Steel Exposition of the Association of Iron and Steel Electrical Engineers, to be held in the Hotel Stevens, Chicago. One of the outstanding features of the convention is the exhibition of power equipment used in the steel industry. There will be six technical sessions and a number of inspection trips during the five days of the convention.

Among the papers of interest to power engineers are: Report of Electrical Development Committee, by W. H. Burr; Report of Electric Welding Committee, by A. G. Place; Report of Standardization Committee, by A. C. Cummins; "Methods and Systems Used in High-Tension Practices in Modern Plants," by Eugene Vinet; "Boiler Pressures Above 350 Pounds," by J. B. Crane; "Factor Governing the Purchase of Coal," by Morgan B. Smith; "Instruments in the Iron and Steel Industry," by E. C. Eagles. At the Thursday morning session there well be three papers presented on anti-friction bearings.

Plans for June Meeting of A.S.H. & V.E. Underway

At a council meeting of the American Society of Heating and Ventilating Engineers held at the Union League Club, Chicago, Ill., on March 28, a tentative program for the semi-annual meeting was presented by Professor Rowley, and indicates that some fine technical sessions are in prospect for members who come to West Baden, Ind., June 26 to 29. C. R. Ammerman, of Indianapolis, was unanimously chosen chairman of the Committee on Arrangements for this meeting. The Council decided that the annual meeting of the Society in 1929 would be held in Chicago, Jan. 28-31, and also that Cleveland would be the site of the semi-annual meeting in June, 1929.

Welding Symposium Held at Lehigh

"The Efficacy of Welding in Repair Work" was the subject of the Annual Welding Symposium at Lehigh University, held in Bethlehem on Monday, April 16th. This meeting, which was attended by about 400 engineers from manufacturing organizations in the Lehigh Valley, was directed this year by Prof. Bradley Stoughton, Head of the Department of Metallurgy. The principal speakers on the subject of the meeting were: A. F. Keogh, president, Sound Welding Company, New York City; John C. Reed, Bethlehem Steel Company, Steelton, Pa.; and J. H. Weiss, New York Central Railroad Company, Poughkeepsie, New York.

During the afternoon demonstrations of the three methods of welding were conducted and a number of tests made on specimen welds.

Discussion of the papers presented in the morning session was postponed until evening when F. W. Miller, J. W. Owen, A. C. Bissel and F. T. McKibbon took part in a discussion that centered around structural steel welding and managerial aspects.

Coming Conventions

American Association of Engineers, annual convention, El Paso, Texas, June 4-6; M. E. McIver, secretary, 63 Adams St., Chicago.

American Boiler Manufacturers Association, annual convention, at Buckwood Inn, Shawnee-on-the-Delaware, Pa., June 11-13; A. C. Baker, secretary, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Order of Steam Engineers, convention at Atlantic City, N. J., June 11-14, and exhibition with American Supplymen's Association. Address Fred L. Jahn, Watson of McDaniel Company, 146 N. Seventh St., Philadelphia.

American Refractories Institute, annual meeting at White Sulphur Springs, W. Va., May 8-9; Dorothy A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh.

American Society of Refrigerating Engineers, meeting at Detroit, June 4-7; W. H. Ross, secretary, 37 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, Summer meeting at West Baden Springs Hotel, West Baden, Ind., June 26-29; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City; Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

American Welding Society, annual meeting, 33 West 39th Street, New York City, April 25-27; M. M. Kelly, Secretary.

Association of Iron and Steel Electrical Engineers, annual convention and Iron and Steel Exposition at Hotel Stevens, Chicago, June 25-29.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago. New England States Association convention at Hartford, Conn., June 21-23; K. W. Lundberg, secretary. Foot Guard Armory, Hartford. New Jersey State convention at the Plaza Hotel, Journal Square, Jersey City, N. J., June 2-3; T. M. Gray, State Secretary, 46 West 51st St., Bayonne, N. J.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Large Glass-Bulb Rectifier Installed in London Station

An enlarged and remodeled generating station has just been opened up in the Shoreditch district of London, England. The new power generating equipment consists of a 12,500-kva. 6,600-volt 3,000-r.p.m. turbine-generator. The most interesting section of the plant is the rectifier equipment, which aggregates 2,300 kw. and is claimed to be the largest glass rectifier bank yet installed. The original mercury arc equipment was installed in 1925, and so far it has not been necessary to change a bulb. Ultimately, 6,000 kw. of these rectifiers is to be installed. The installation is supplied at 6,600 volts three-phase 50 cycles, and is connected into a three-wire 250 and 500-volt network.

Largely as a result of recent improvements in glass blowing, glass-bulb rectifiers are being used in Europe on an increasing scale for large outputs. Only a few years ago glass-bulb rectifiers were in use up to 40 ampere rating. At the present time plants of this type are being made for 200 kw. at 600 volts. The main object when installing such a plant is to make each bulb rectifier and its accessories an entirely self-contained unit. With this arrangement simplicity in operation is obtained.

Harrah Station Enlarges Capacity 30,000 Kw.

Construction work on the addition to the Harrah steam-electric station of the Oklahoma Gas & Electric Company near Oklahoma City, is progressing satisfactorily, according to H. W. Fuller, Vice-President in Charge of Engineering and Construction, Byllesby Engineering & Management Corporation.

Work on this addition was started in October, 1927, and the installation will comprise an extension to the power-station building containing an additional turbine unit of 30,000 kw. capacity, with condensers and necessary auxiliary equipment, and two boilers with a capacity of 250,000 lb. of steam per boiler. Powdered fuel will be used.

This is the third generating unit to be installed in the Harrah Station and, when completed, will give the station a capacity of 65,000 kw. Work is expected to be completed about Sept. 1, 1928.

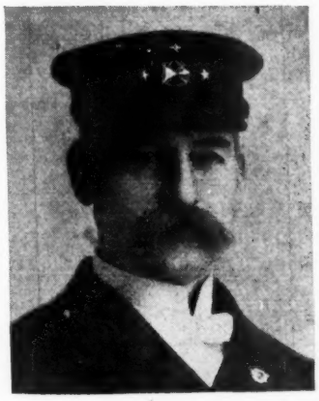
Detroit Edison Builds Delray No. 3

At a meeting of the Detroit Edison Power Club, Alex Dow, president of the Detroit Edison Company, revealed some of the major design features of the new plant that is being built near the site of the old Delray Station, and known as Delray No. 3. As reported by the Detroit Edison Synchroscope, Mr. Dow said that Trenton Channel has been making as good an all-year-round showing as any plant anywhere in the world, provided all factors are considered and graded. This showing takes countenance of economy, reliability of service, load factor and all of the variables that enter into plant operation. There is therefore every probability that, as to most features, Delray No. 3 will follow along the lines of Trenton Channel. There will be a change in boiler practice to single-ended boilers, turbines will be identical with Trenton Channel turbines, and temperature and pressure will in all likelihood not be vastly different. Turbine rotors for the first two units will be interchangeable with the Trenton Channel rotors.

The first section of this plant will contain two identical units of 50,000 kw. capacity each. These, it is planned, will be placed in operation some time in 1928.

Lewis F. Lyne, Engineer And Writer, Dies

LEWIS F. LYNE, chief engineer of Colgate & Company, died at Christ Hospital in Jersey City March 16, at the age of eighty years. Born at Clinton, Conn., Mr. Lyne served his apprenticeship at the Altoona Shops of the Pennsylvania R.R. and was later employed by the Lake Shore R.R. at Cleveland, and the D. L & W. R.R. at Hoboken. In 1878 he joined the editorial staff of the *American Machinist* and soon became widely known through his plain, practical writings on engineering matters. He was one of the first, if not the first, to apply the indicator to locomotives. Mr. Lyne was one of two engineers who made the first test of the Edison system of incandescent lighting, erected at Menlo Park, N. J. At the beginning of the World War, Mr. Lyne enlisted in the U. S. Ordnance Department as inspector and served in that capacity until the Armistice was signed. Upon leaving the government service, he joined the engineering department of Colgate & Company with which company he remained until his death.



Lewis F. Lyne

Large Sulzer Single-Acting Oil Engine Completed

Trials have recently been completed at the Sulzer works at Winterthur, Switzerland, of the largest single-acting oil engine yet constructed for either marine or stationary purposes. It is a two-stroke-cycle design of normal Sulzer construction and develops 7,040 hp. at the moderate speed of 100 r.p.m. It is for installation in a single-screw cargo vessel of about 12,000 tons deadweight, now being built in Holland for the Netherland Steamship Company. Four similar vessels are being built.

The engines have eight cylinders with a diameter of 820 mm., (32.2 in.), and a stroke of 1,440 mm., (56.6 in.). These dimensions are slightly smaller than those of the double-acting four-stroke-cycle Harland-Burmeister & Wain engines installed in the "Asturias" and "Alcantara," which have eight cylinders 840 mm. (33 in.) in bore with a piston stroke of 1,500 mm. (59 in.). The output of the "Alcantara's" engines is somewhat higher, being about 7,500 hp. at 110 to 115 r.p.m.

The large Sulzer engine is arranged to operate with turbo-blowers for supplying the scavenging air, although the Brown-Sulzer engines which are being built in Scotland, and designed to develop nearly 1,000 hp. per cylinder, are provided with a reciprocating scavenging pump.

New Steam Station for Grays Harbor, Washington

The Grays Harbor Railway & Light Company of Washington has announced plans for a $1,500,000 steam power project which will add 10,000 hp. to the supply now available on Grays Harbor. The project calls for a large supplementary plant at the electric park power station.

Work will start at once and the plant will probably be finished by Dec. 1, according to W. W. Briggs, vice-president and general manager of the power company.

OBITUARY

A. L. BROOMALL, aged 44 years, manager of the renewal parts engineering department of the Westinghouse Electric & Manufacturing Company, died Tuesday morning, April 10, at his home, 814 Mifflin Avenue, Wilkinsburg, from pneumonia. Mr. Broomall was born June 27, 1884, in Lenni, Delaware County, Pa., and was educated at the Westchester State Normal School and Lehigh University, graduating from the latter institution in 1906 with the degree of bachelor of science in electrical engineering. Immediately after graduation

he entered the graduate students' course of the Westinghouse company, and continued to work for that company until his death. He was a member of the American Institute of Electrical Engineers and the American Electric Railway Association.

WILLIAM ROBERT QUINN, well-known designer of fuel-oil burning equipment, died suddenly of heart disease at the Hotel Manger, New York, on April 12. Mr. Quinn has been a resident of San Francisco for several years past, having gone there as the Pacific Coast representative of Combustion Engineering Corporation. He was in New York on a business trip at the time of his death. He was president of the Quinn Oil Burner & Torch Company until this company was purchased by Combustion Engineering Corporation in 1922. He then became manager of the fuel oil burning equipment department of the latter organization, which position he held until he went to San Francisco as Pacific Coast representative.

JAMES H. BRADLEY, for the last ten years the superintendent of the Russell Electric Light plant, died March 31, from pneumonia after six days of illness.

FREDERICK SITTERDING, former president of the Virginia Electric & Power Company and active in public life in Richmond, for many years, died at his home in that city April 5.

SOCIETY AFFAIRS

A.S.M.E. BUFFALO SECTION, Statler Hotel, Buffalo, N. Y., April 24, "Direct Fired Powdered Coal Boilers with Well Type Furnaces at the Charles R. Huntley Station," by H. M. Cushing, chief engineer, Buffalo General Electric Company, Buffalo, N. Y.

A.S.M.E. CINCINNATI SECTION, Engineers Club, Ninth and Race Sts., Cincinnati, Ohio, April 26; "An Engineering Paradox" is the subject of an address by Dean F. Paul Anderson, Dean of the College of Engineering, Kentucky State University.

A.S.M.E. METROPOLITAN SECTION, Engineering Societies Building, 29 West 39th St., New York City, April 24, "Shaft Behavior, Critical Speeds and Some Causes of Vibration of Rotating Shafts," by Dr. Burt L. Newkirk, engineer, Research Laboratory, General Electric Company. This paper will be illustrated with lantern slides and will discuss some of the causes of vibration of rotating shafts and the methods used in studying the vibration of heavy machinery.

A.S.M.E. SAN FRANCISCO SECTION, Engineers Club of San Francisco, Calif., April 26; fundamental principles involved in problems of small high-speed Diesel engines will be discussed by Paul Joslyn, consulting engineer.

ENGINEERING INSTITUTE OF CANADA, Western General Professional Meeting at Vancouver, B. C., June 7-9; R. J. Gurley, Secretary, Montreal, Quebec.

AMERICAN ENGINEERING COUNCIL: Spring meeting of the Administrative Board, Milwaukee, Wis., May 10-11. May 10 will be reserved for meetings of committees, while the entire day of May 11 will be devoted to sessions of the Administrative Board.

PERSONALS

W. G. OWEN, formerly sales manager of the Haws Refractories Company, Philadelphia, has become associated with the General Refractories Company, Philadelphia, Pa. Mr. Owen will assume charge of the Philadelphia territory, relieving L. Tschirky, who will devote his time to general sales promotion and the sales development of the company's specialty products.

CARL F. SCOTT, manager of building equipment sales, General Electric Company, has entered the employ of the Gurney Elevator Company in New York as assistant sales manager. Mr. Scott is a graduate of Haverford College and has been in the employ of the General Electric Company since 1908.

L. A. MCARTHUR, vice-president of the Pacific Power & Light Company, Portland, Oregon, will sail shortly for a five-week tour of England.

HAROLD C. DAVIS has been named manager of the Missouri Power & Light Company at Plattsburg, Mo. He will succeed L. J. Edmonston, who has been promoted to district manager of the company at Edina, Mo.

BUSINESS NOTES

THE CUTTER ELECTRICAL & MANUFACTURING COMPANY, of Philadelphia, manufacturer of I-T-E circuit breakers and U-Re-Lites switches recently changed its name to the I-T-E Circuit Breaker Company. According to Philip C. Gunion, sales manager of this company, "The primary reason for changing the name was that it was constantly being confused with two other electrical manufacturers of similar name. The policies, personnel and products of the I-T-E Circuit Breaker Company are identical with those of the old company—nothing has been changed except the name."

THE GIFFORD-WOOD CONSTRUCTION COMPANY, of New York, has absorbed the Warford Construction Company, of Aurora, Ill. Both companies have been closely associated with Gifford-Wood Company. In the past the Gifford-Wood Construction Company operated only in the East and the Warford Construction Company in the Middle West. Hereafter the Gifford-Wood Construction Company will cover the entire territory from its main office, Graybar Bldg., Lexington Ave., New York City, with a branch office at 565 W. Washington St., Chicago, in charge of W. H. Warford, former president of the Warford Construction Company. The Concrete Products plant at Aurora, Ill., will continue in operation under the new management. The complete personnel of the Warford Construction Company has been retained by the Gifford-Wood Construction Company and will remain in the Western territory. The new officers are: James E. Moul, president; W. H. Warford, vice-president, and W. Thorning Wood, secretary and treasurer. Benedict Gifford, president of Gifford-Wood Company, is a director.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.10@$2.40
Kanawha.....	Columbus.....	1.25@ 1.60
Smokeless.....	Cincinnati.....	1.75@ 2.00
Smokeless.....	Chicago.....	2.00
S. E. Kentucky...	Chicago.....	1.35@ 1.60
Steam.....	Pittsburgh.....	1.40@ 1.60
Gas Slack.....	Pittsburgh.....	1.00@ 1.20
Big Seam.....	Birmingham....	1.40@ 1.75
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$3.00@$3.50
Birdseye.....	New York.....	1.60

FUEL OIL

New York—Apr. 19, industrial use, tank-car lots, 28@34 deg., Baumé, 4¾c. per gal.; 36@40 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Apr. 12, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5c. per gal.

Pittsburgh—Apr. 10, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5¼c. per gal.

Philadelphia—Apr. 18, 26@30 deg., $1.90@$1.97 per bbl.; 13@19 deg., $1.15 @$1.22 per bbl.; 22 plus, $1.51@$1.58 per bbl.; 27@30 deg., $2.10@$2.17 per bbl.

Cincinnati—Apr. 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Apr. 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90@95c. per bbl.; 30@32 deg., $1.05@$1.10 per bbl.

Boston—Apr. 9, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5¾c. per gal.

Dallas—Apr. 14, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

THE DAMPNEY COMPANY OF AMERICA, Hyde Park, Boston, Mass., announces that the sale of its APEXIOR Protective Coatings for power-plant equipment will be handled in Colorado, western Nebraska, eastern Wyoming and northern New Mexico by Joy & Cox, Inc., 314 Tramway Building, Denver, Colorado.

THE TRICO FUSE MANUFACTURING COMPANY, Milwaukee, Wis., makers of TRICO fuses, announces the removal of its Pittsburgh office to new and larger quarters at 405 Penn Ave.

AMERICAN HOIST & DERRICK COMPANY, announces that on May 1, the Pittsburgh office of the company will be moved from 1423 Farmers Bank Building to 604 Chamber of Commerce Building.

THE R. D. NUTTALL COMPANY, McCandless Ave., Pittsburgh, Pa., announces that its commercial activities will be handled by and through the parent company, the Westinghouse Electric & Manufacturing Company, under the direction of J. E. Mullen, formerly Assistant sales manager of the R. D. Nuttall Company. All inquiries, etc., should be addressed to the nearest district office of the Westinghouse Electric & Manufacturing Company.

TRADE CATALOGS

VACUUM HEATING PUMPS—The Ames Pump Company, 90 West Street, New York City, has issued a two-color bulletin No. 52, which completely describes the operation of the Vacuum Heating Pumps the company manufactures. The bulletin contains many half-tone illustrations of the pump, together with cutaway sections that help in following the cycle of operation. Detailed data and dimensions are given for both single and duplex units. Charts are given for determining vacuum and temperature, gallons per minute of condensates per square feet of direct radiation and the cubic feet of air discharged, under 10-in. vacuum for various sizes of orifices.

SUPERHEATER—In a pamphlet issued by the Superheater Company, 17 East 42d Street, New York City, is related the features of and results obtained with the Elsco superheater. Lists are given of typical industrial and central-station installations.

ELECTRIC APPARATUS FOR COTTRELL PRECIPITATION PROCESS — Bulletin G.E.A.-916 of the General Electric Company, Schenectady, N. Y., has 16 pages dealing with the application of the equipment used in the Cottrell precipitation process. In addition to describing the equipment and its applications the bulletin also contains a bibliography of articles on the theory of electrical precipitation and its application to industries.

PNEUMATIC TOOLS — The Chicago Pneumatic Tool Company, New York, in its new catalog No. 561, describes its complete line of pneumatic tools and accessories including riveting and clipping hammers, scaling tools, tampers, sand rammers, air drills, grinders and geared air hoists. Charts showing styles and dimensions of rivet sets and chisels are also included.

INDUSTRIAL CONTROL—The General Electric Company, Schenectady, N. Y., now has available its 1928 Industrial Control Catalog G.E.A.-606, which contains 190 pages. This catalog briefly describes the different classes of the company's industrial control equipment and its applications. Rating, dimensions and prices are also given.

SPLIT-PHASE MOTOR — A six-page bulletin No. 153, has recently been published by the Wagner Electric Corporation on its new Type 58RB split-phase induction motor. One of the features is a new type of starting-winding switch.

NEW PLANT CONSTRUCTION

Compiled by the McGraw-Hill Business News Department, which is prepared to furnish a more complete daily service to those who wish it

Ala., Phenix City—Waterworks Commission, will receive bids until May 3 for waterworks improvements including reservoir, purification plant, pumping station, etc. Warren E. Darrow, Engrs., Columbus, Ga., are engineers.

Ark., Cotter — White Power Co., C. J. Dahlke, Pres. and Gen. Mgr., Neshkoro, Wis., has been granted permit for the construction of a 26 ft. dam on the White River near here to develop 70,000 hp. hydroelectric energy.

Ark., Little Rock—Arkansas Cold Storage Co., Ft. of Rock St., plans the construction of a cold storage warehouse. Estimaetd cost $100,000.

Calif., Grass Valley—Nevada Irrigation Dist. plans an election to vote $2,592,000 bonds for completion of irrigation work, including Deer Creek storage reservoir, general extension of distribution system, etc. F. H. Tibbetts, Alaska Commercial Bldg., is engineer.

Calif., Holtville — City voted $40,000 bonds for waterworks improvemenst including 4,000,000 gal. reservoir, pumping equipment, mains, etc. Burns-McDonnell-Smith Engineering Co., Western Pacific Bldg., Los Angeles, is engineer.

Calif., Santa Clara—Pacific Mfg. Co. of Santa Clara is having plans prepared for a plant including boiler house. Estimated cost $225,000. Hamn, Grant & Bruner, Inc., 607 Ferguson Bldg., Los Angeles, Archts.

Calif., Watsonville—Coast Counties Gas & Electric Co., Russ Bldg., San Francisco, awarded contract for the construction of a sub-station to J. Renfrew, Watsonville. Estimated cost including equipment $30,000.

Colorado—Southern Colorado Power Co., W. N. Clark, Gen. Mgr., Fourth and Main Sts., Pueblo, plans extensions and improvements in 1928 on company's property in southern Colorado including transmission lines and equipment, etc. Estimated cost $275,000.

Colo., Denver—City and County will receive bids until May 23 for the construction of a court house including boiler house at Bannock St. between 14th and 15th Sts. Estimated cost $5,000,000. Allied Architects Assn. of Denver, Insurance Bldg., is architect.

Conn., Hartford—Bd. of Contract & Supply plans the construction of dykes, 3 mi. long enclosing 1,200 acres, also pumping station and equipment in West Meadow. Estimated cost $1,000,000. R. N. Clark, City Hall, is engineer. Fay, Spofford & Thorndike, 44 School St., Boston, Mass., are consulting engineers.

Ill., Chicago — Horder's Inc., 236 West Lake St., had plans prepared for an 8 story office and warehouse at Jefferson and Quincy Sts. Estimated cost $500,000. S. N. Crowen & Co., 22 West Monroe St., are architects.

Ill., Chicago—Koenigsberg & Weisfeld, 155 North Clark St., Archts., are receiving bids for an 8 story apartment building including central refrigeration plant, elevators, etc. at 420 Surf St. for S. Clifford & Co., 111 West Washington St. Estimated cost $585,000.

Ill., East St. Louis—East Side Levee & Sanitary Dist., Metropolitan Bldg., is having preliminary plans prepared for the construction of a pumping plant and equipment for levee district. Plans include either one large unit or two smaller ones. E. F. Harper, c/o owner, is engineer.

Ill., Flossmoor—Flossmoor Lodge, Inc., c/o J. C. McKinsey, 7 South Dearborn St., Chicago, is having plans prepared for the construction of a sanitorium and hotel including swimming pool, etc., here. Estimated cost $1,200,000. D. G. Wallace, 22 West Monroe St., Chicago, is architect.

Ind., Indianapolis—L. S. Ayres Co., Meridian and Pearl Sts., will receive bids until Apr. 30 for an 8 story department store including steam heating system, elevators, etc. Estimated cost $1,500,000. Vonnegut, Bohn & Mueller, 610 Indiana Trust Bldg., are architects.

Ia., Emmetsburg—Municipal Utilities Co., Des Moines, has been granted franchise to construct and operate a municipal electric light and power plant here. Estimated cost $150,000.

Md., Baltimore—Bethlehem Shipbuilding Corp., awarded contract for the construction of an office building including a 40 x 80 ft. power plant, etc., on Key Highway, to Consolidated Engineering Co., 20 East Franklin St.

Mass., Boston—Penal Institution Dept., will soon award contract for the construction of a power house and heating plant at Deer Island, Boston Harbor. Estimated cost including equipment $200,000.

Mass., Marshfield—City will soon award contract for the construction of a pumping station. Symonds & Stevens, 70 State St., Boston, are engineers.

Mass., Mattapan (Boston P. O.)—Hospital Dept., Boston, is having sketches made for addition to boiler plant at Tuberculosis Hospital, River St. here. Estimated cost $175,000.

Minn., Minneapolis—Northwestern National Bank, Marquette Ave. and Fourth St. and L. S. Donaldson Co., 6th St. and Nicollet Ave., is having plans prepared for a 16 story bank and office building including steam heating system, elevators, etc. at Marquette Ave. between Sixth and Seventh Sts. Estimated cost $4,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., are architects.

Mo., Kennett—City plans the construction of an electric light and power plant Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., is engineer.

Mo., St. Louis—City College Development Corp., c/o City College of Law and Finance, Mid-City Bldg., is having preliminary plans prepared for a 14 story office building at Olive and 14th Sts. Estimated cost $800,000.

Mo., St. Louis — Owner, c/o Pleitch & Price, 1592 Arcade Bldg., Archts., awarded contract for a 15 story apartment building at 3745 Lindell St., to Selden-Breck Construction Co., 1108 Fullerton Bldg. Estimated cost $1,000,000.

N. J., Netcong — Deborah Jewish Consumptive Relief Society, M. L. Unger, Chn., 24 Branford Pl., Newark, N. J., plans the construction of a 4 story sanitorium here. Estimated cost $1,000,000. Architect not selecetd.

N. J., Teaneck — Holy Name Hospital, Teaneck Rd., is having sketches made for a 5 story addition to hospital including steam heating and ventilation systems, boilers, etc., on Teaneck Rd. Estimated

cost $800,000. V. Reeser, 55 West 42nd St., New York, N. Y., is architect.

N. Y., Binghamton — Dept. of Mental Hygiene, Capitol, Albany, awarded contract for the construction of a cold storage plant at Binghamton State Hospital here, to Hamel Construction Co., Inc., Plymouth Bldg., Cleveland, O. Estimated cost $62,870.

N. Y., New York—Goldbelt Realty Corp., 408 Lexington Ave., will receive bids about May 1 for the construction of a hotel at 585 Lexington Ave. Estimated cost $960,000. W. Van Alen, 331 Madison Ave., is architect.

N. Y., New York—Max Natanson, 522 5th Ave., plans the construction of a 34 story office building at Herald Sq. Estimated cost $4,000,000. Clinton & Russell, 17 John St., are architects.

O., Lakewood—Lake Shore Hotel, c/o C. R. Cummins, Penton Bldg., Cleveland, is receiving bids for a 10 story hotel including steam heating and refrigeration systems, boilers, elevators, etc. at Edgewater Dr. and Cove Ave. Estimated cost $2,000,000. F. W. Bail, Hanna Bldg., Cleveland, is architect.

Okla., Oklahoma City—Artic Ice Co., 3 East 10th St., plans addition to ice plant. Estimated cost $100,000.

Ore., Eugene—City will receive bids about May 15 for the construction of Leaburg hydro-electric development including power house, dam, penstock, pumps, etc. Estimated cost $1,500,000. Stevens & Koon, Spalding Bldg., Portland, are engineers.

Ore., Portland—L. L. Dougan, Kreamer Bldg., Archt., awarded contract for a 10 story medical and dental office building at Taylor and 11th St. to Dougan-Hammond Construction Co. Estimated cost $850,000. Steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. will be installed.

Pa., Kittanning—U. S. Engineer Office, Keenan Bldg., Pittsburgh, will soon award contract for the construction of a power house for Lock No. 6 on Allegheny River here. Estimated cost $35,000.

Pa., Philadelphia—Dwight P. Robinson & Co., 125 East 46th St., New York, N. Y., awarded contract for a 21 story apartment building at 239-47 South 18th St., here, to United Engineers & Construction, Inc., Broad and Arch Sts., Philadelphia. Estimated cost $2,500,000.

Pa., Philadelphia—Reading Co. plans the construction of a 10 story commercial warehouse at Noble, 13th, Callowhill and Broad Sts. Estimated cost $3,000,000. C. Dillenback, Reading Terminal, is architect.

Pa., Philadelphia—Stenton Corp., c/o A. Hebs, Broad and Spruce Sts., is having plans prepared for a 24 story apartment building at Broad and Spruce Sts. Webber & Wurster, 1530 Locust St., are architects.

R. I., Providence—St. Joseph's Hospital Corp., W. A. Hickey, is having plans prepared for a 6 story addition to hospital at Peace and Broad Sts. Estimated cost $500,000. A. J. Murphy, 25 Fenner St., is architect.

Tenn., Memphis—Shelby County, E. W. Hale, Comr., had plans prepared for the construction of a work house including power plant, etc. at Mullins Station. Estimated cost $350,000. Hanker & Cairns, Court Ave., are architects.

Tex., Abilene—Middle West Utilities Co., 72 West Adams St., Chicago, Ill., plans the construction of a power plant on the Colorado River here. Estimated cost $1,000,000.

Tex., Beaumont—E. G. Edson, c/o Edson Realty Co., will receive bids until Apr. 23, for a 19 story hotel at Peare and Liberty Sts. Estimated cost $1,500,000. F. W. Steinman & Son, 410 San Jacinto Life Bldg., are architects, and Hedrick & Gottlieb, Post Dispatch Bldg., Houston, are consulting architects.

Tex., Dallas—City plans the construction of a water purification plant, pumping stations, mains, etc. Estimated cost $4,000,000. Fuller & McClintock, 170 Broadway, New York, N. Y., are consulting engineers.

Tex., Eagle Pass—Maverick County Improvement Dist. No. 1, will soon receive bids for the construction of a hydro-electric plant near here in connection with irrigation project. Estimated cost $500,000. W. L. Rockwell, is engineer.

Tex., Plainview—Texas Utilities Co., c/o B. Scott, Mgr., is having plans prepared for the construction of a superpower plant near present system of generating plants and transmission lines, probably near Panhandle in Carson county. Estimated cost $600,000. Private plans.

Wash., Aberdeen—The Grays Harbor Railway & Light Co., W. W. Briggs, Gen. Mgr., plans the construction of a new unit to central generating plant at Electric Park to develop 10,000 hp. Estimated cost $1,500,000.

W. Va., Charleston — Kanawba Valley Bank, J. L. Dickinson, Pres., will soon award contract for a 20 story bank and office building including steam heating, ventilation and refrigeration systems, pumps, elevators, etc., at Lee and Capitol Sts. Estimated cost $2,500,000. A. C. Bossom, 680 5th Ave., New York, N. Y., is architect. C. A. Havilond, Charleston, is associate architect.

Wis., Milwaukee — Terminal Warehouse Co., E. D. Fryer, Pres., 272 South Water St., will soon award contract for a 4 story addition to storage warehouse including cold storage plant, etc. at West Water and Buffalo Sts. Estimated cost $1,000,000. W. F. Dolke, Evanston, Ill., is architect.

South Africa, Johannesburg — Municipal Council, has authorized fund of £510,000 (about $2,448,000) for the construction of a new municipal electric light and power plant, initial capacity 39,000 kw.

Equipment Wanted

Boiler and Stoker—Borough of Aspinwall, J. W. Hartley, Secy., 217 Commercial Ave., Aspinwall, Pa., will receive bids until Apr. 25 for one 300 hp. horizontal water boiler and stoker.

Boilers, Stokers, Coal and Ash Handling Equipment, etc.—Bd. of Trustees, Indiana University, J. W. Cravens, Secy., Bloomington, Ind., is receiving bids for chimney boilers, mechanical stokers and coal and ash handling equipment for boiler plant.

Electric Light Plant Equipment—Town of Columbia, S. C., W. J. White, Mayor, will receive bids until May 7 for furnishing and installing electric light plant equipment including a 120 hp. unit, a.c. and alternator for 25 hp. engine, also a 120 hp. generator set and two generators for a 25 hp. engine now in use.

Engine — Northwestern Light & Power Co., A. C. Sloss, Mgr., Peterson, Ia., plans to purchase a 600 hp. Diesel engine for proposed extensions and improvements to power plant. Estimated cost $60,000.

Engine Units—City of Elgin, Ill., plans to purchase two Diesel engine units, etc., for proposed complete electrification of pumping plant. Estimated cost $35,000.

Electrical Equiment—G. E. Gross, County Clk., Oakland, Calif., will receive bids until May 7 for electrical equipment including transformers, switchboards, electric heaters, conduits, etc., for Oakland-Alameda Estuary tube project.

Motors—City of Amarillo, Tex., will purchase two 2 hp. and one 15 hp motors in connection with waterworks.

Power Plant Equipment—Public Lighting Comn., 172 East Atwater St., Detroit, Mich., plans the installation of additional power plant equipment including a 20,000 kw. unit with pumps, transformers, boiler and stokers, condensers, etc., in existing power plant on Morrell St. Estimated cost $800,000.

Pump—City of Apache, Okla., is in the market for a 250 g.p.m. centrifugal pump with marine engine drive for waterworks.

Pump—Bd. of Awards, City Hall, Baltimore, Md., will receive bids until Apr. 25 for furnishing and installing a turbo-driven centrifugal pump in Eastern Ave. sewage pumping station.

Pumping Equipment — Dept. of Public Works, Bureau of Water, City Hall, Philadelphia, Pa., will receive bids until Apr. 26 for motor driven pumping equipment and auxiliaries also electrical equipment, switchboards, etc. for Belmont pumping plant.

Pumps—A. J. Hawkins, City Engineer, Birmingham, Ala., will receive bids until May 8 for furnishing and installing 600 g.p.m. electric sewage pumps.

Pumps, Motors and Engine — City of Hominy, Okla., is in the market for two 250 g.p.m. centrifugal pumps and motors and one 150 hp. Diesel engine for waterworks.

Refrigeraotrs, Compressors, Condensors, etc. — Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans furnishing and installing refrigerators with motor-driven compressors, condensers, etc., for Navy Yard (Hospital) Mare Island, Calif.

Switchgears—State Electricity Commission, 22-32 William St., Melbourne, Australia, will receive bids until Sept. 3 for a 120,000 v. switchgear for Richmond Terminal Station, also 135,000 v. switchgear for Yallourn power station extension.

Industrial Projects

Calif., Berkeley—PICKLE FACTORY—Frank Pickle Co. awarded contract for a 1 and 2 story, 150 x 300 ft. factory including loading platforms, elevator, etc., on Berkeley St., to Austin Co. of California, 777 East Washington St., Los Angeles. Estimated cost $250,000.

Calif., Los Angeles—ASSEMBLY PLANT—Willys-Overland Co., 2141 Colorado Eagle Rock, manufacturers of automobiles, is having plans prepared for the construction of an assembly plant on Randolph St. Estimated cost $750,000. Austin Co. of California, 777 East Washington St., is engineer.

Calif., Pittsburg — ASBESTOS PRODUCTS FACTORY—H. W. Johns-Manville Co., Inc., of California, 159 New Montgomery St., San Francisco, is having plans prepared for two 1 story, 100 x 500 ft. factory buildings for the manufacture of asbestos products, roofing, etc. Estimated cost to exceed $1,000,000. H. J. Brunnier, Sharon Bldg., San Francisco, is engineer.

Ill., Chicago—CAN MANUFACTURING PLANT — Continental Can Co., 100 East 42nd St., New York, N. Y., will receive bids May 1 for a can manufacturing plant at 35th and Rockwell Sts., here. Estimated cost $1,000,000. Francisco & Jacobs, 511 5th Ave., New York, are architects and engineers.

Ill., Chicago — VALVE and FITTING FACTORY—Graham, Anderson, Probst & White, 80 East Jackson Blvd., Archts., will receive bids until Apr. 28 for a 3 story, 82 x 502 ft. addition to factory for the manufacture of valves, fittings, etc., at 4100 South Kedzie Ave. for Crane Co., 826 South Michigan Ave.

Mich., Detroit — METAL PRODUCTS FACTORY — Wise Chrome Products Co., 2474 Bellevue Ave., awarded contract for a 1 and 2 story, 72 x 133 ft. factory to H. G. Winter, 159 East Elizabeth St. Estimated cost $50,000.

Mich., Saginaw — AUTO FACTORY BUILDINGS—General Motors Corp., General Motors Bldg., Detroit, is having plans prepared for three units to factory including pattern shop, foundry, cleaning building, etc., here. Estimated cost $1,500,000. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Mo., St. Louis — FOUNDRY — Century Electric Co., Inc., 1806 Pine St., will soon receive bids for the construction of a foundry at 3739 Market St. Estimated cost $200,000. Klipstein & Rathmann, Security National Bank Bldg., are architects.

Mo., St. Louis—PACKING PLANT ADDITION—Swift & Co., Construction Dept., Union Stock Yards, Chicago, Ill., are receiving bids for a 6 story addition to packing plant at Vandeventer and Papin Sts., here. Estimated cost $600,000. Also plans a plant at Vernon, Calif.

N. C., New Bern—CEMENT PLANT—Carolina Cement Co., R. C. Clark, Secy. and Treas., Raleigh, plans the construction of a plant for the manufacture of portland cement from native marl here. Estimated cost $3,000,000.

O., Cleveland—AIR COMPRESSOR FACTORY — The U. S. Air Compressor Co., 5300 Harvard Ave., had plans prepared for a 1 story, 141 x 151 ft. addition to factory. Estimated cost $50,000. G. S. Rider Co., Century Bldg., is architect.

O., Youngstown — STEEL MILL — Carnegie Steel Co. plans the construction of a steel mill on McDonald St. Estimated cost $500,000.

R. I., Pawtucket — INSULATED WIRE FACTORY — Collyer Insulated Wire Co., 249 North Main St., will soon award contract for a 3 story, 80 x 106 ft. addition to factory. Estimated cost $100,000. Monahan & Miekle, 255 Main St., are architects.

W. Va., Charleston — COMPRESSED GAS PLANTS — Linde Air Products Co., South Charleston St., awarded contract for a 130 x 300 and 130 x 250 ft. plant to Stone & Webster, 4 Milk St., Boston, Mass. Estimated cost $1,000,000, also a plant at Harrisburg, Pa., to F. D. Groot Co., Harrisburg.

Wis., Eau Claire—MILK PLANT—Eau Claire Milk Producers Co-Operative Assn. will soon award contract for a 4 story milk plant. Estimated cost $200,000. E. J. Hancock, Eau Claire, Wis., is architect. Douthitt, 139 North Clark St., Chicago, Ill., is engineer.